APPENDIX A.

SYLLABUSES OF WORK IN VARIOUS HANDWORK SUBJECTS.*

1. DOMESTIC SUBJECTS.

(i) THE BRADFORD GIRLS' GRAMMAR SCHOOL.

SCHEME OF WORK IN SCIENCE AND IN DOMESTIC ARTS, AND NOTES ON THEIR CORRELATION, 1911-1912.

[*Note supplied by the Headmistress.*—This is the eighth School year since we began compulsory work in Cookery and Housewifery for all girls throughout the year they spend in the Lower Fifth Form (age about 15-16).

Our reasons for putting this work neither earlier nor later in the school course are:—(1) at fifteen girls are able to manipulate kitchen utensils and to do household work in a way they cannot attempt when too young; (2) they have no outside examinations for a leaving certificate to aim at until the following year; (3) many girls leave school without reaching a higher form than this, and we want to make sure, as far as possible, that no girl shall leave without this instruction.

(In 1904 a visiting teacher of Cookery was engaged, but we had no proper kitchen. A gas stove and gas rings were fixed in one of the Science rooms and white wood tops were made to fit over the teak tables, but the girls could not work under normal conditions. In 1907-8 a room was fitted up as a kitchen with a sink, kitchen range, and gas cooking stove. All Lower V. Form girls (about 60) were taken in groups of 12 for two hours weekly,

In 1907 a group of 12 girls spent a week at a cottage in the country in the charge of the Housewifery teacher, and did all the cooking and household work.

In 1909 a Mistress giving her full time was engaged, and further classes were arranged (1) for backward elder girls who would be likely to leave from the IV. Form, (2) for girls in the Upper V. who desired to go on with the work, and (3) for Bye Students.

In 1911, the kitchen equipment was removed to a much larger room and a scullery was built adjacent to it.

Our Housewifery mistress was herself educated at a High School, and subsequently took a thorough course of training for her work. She is a full member of the staff and co-operates with the two Science mistresses.)

The City Scholars are now sent to us under twelve years of age, and we have quite a number of bright children of eleven in Lower IIIA. We propose to give these an extra year in the middle forms by passing them through a Lower Fourth Form after the Upper Third. These children will thus have a third year for Physics (for elementary work in Light and Electricity).

* Many suggestions for courses in various subjects will be found in the evidence of witnesses. For more detailed statements and suggestions reference may be made to the evidence of the following:—Miss Hitching (Home Management); Miss Ogden (Light Handwork for young children); Miss Swanson (Needlework); Mr. Judd (Constructional Handwork); Dr. Rouse (General); Prof. Smithells (Domestic Subjects and Science).

Our Science teaching, while following a course in which an effort is made to treat scientific principles in logical order and to give them wide application, is correlated with Housecraft. It will be clear that in the following pages it is the points of connection with Housecraft on which emphasis is laid. The course in Elementary Physics in the Lower and Upper III. Forms follows the ordinary lines, and includes all the ordinary illustrations in addition to those given.

Some departure is made from our principle in the latter part of the Chemistry course in the IV. Forms, where chief importance is attached to the study of the properties of common substances of which a certain amount of knowledge is essential to the right understanding of the Cookery and Physiology which follows next year.

The more definitely scientific Chemistry for which this course has paved the way follows in Lower V.

Higher up the School courses in Chemistry and Physics are arranged for girls who wish to specialise in Science. It is likely that with our increased accommodation we shall have more doing this in future.]

SCHEME OF WORK IN SCIENCE AND DOMESTIC ARTS.

PREPARATORY COURSE.

Form I. Average age, 8½.

Seasonal Nature Study (plants and animals), ¾ hr. weekly, treated in Geography lessons.

Common Phenomena.

Needlework.—One lesson of ¾ hr. weekly.

Lower II. Average age, 9½.

Nature Study and *Needlework* as above.

Upper II. Average age, 10½.

Nature Study and *Needlework* as above.

GENERAL COMPULSORY COURSE (4 OR 5 YEARS).

1st Year. Lower III. A. and B. Average age, 11–13.

Physics (classes in 3 divisions). Three lessons of ¾ hr. for 2 terms, 2 lessons of ¾ hr. for 1 term.

Botany, one lesson of ¾ hr. in summer term.

Needlework, one lesson of 1 hr.

2nd Year. Upper III. A. and B. Average age, 12–14.

Physics. (Heat) in 3 divisions, 2 lessons of ¾ hr.

Botany, one lesson of ¾ hr.

Needlework, one lesson of ¾ hr.

Lower IV.

(Extra year for young bright girls who began at 11.)

Physics and *Botany* (*elementary Light* and *Electricity*).

3rd Year. IV. A. and B. Average age, 14–15.

IV. A. (About 30 girls.)	IV. B. I. and IV. 2. (About 36 girls.)
**Chemistry*, 2 hrs.	**Chemistry*, 1½ hrs.
Botany, ¾ hr.	*Botany*, ¾ hr.
	Needlework and *Housewifery*, 1½ hrs.

* IV. A. and IV. B. are divided into three sets for Chemistry.

4th Year. Lower V. A. and B. Average age, 15–16.

Lower V. A. (About 20 girls.)	Lower V. B. (About 30 girls.)
Chemistry, 2½ hrs. (in two sets).	*Botany*, ¾ hr.
Physiology and *Hygiene*, 1 hr.	*Physiology* and *Hygiene*, 1¾ hrs.

(Circulation, respiration, digestion, sanitation and personal hygiene.)
Cookery, Laundry and Housewifery.

Two hours practical work in the kitchen every week is compulsory for all these girls.

5th Year. Upper V. A. and B. Average age, 16–17.

Up. V. A. (About 20 girls.)	Up. V. B. (About 15 girls.)
Botany (for Higher certificate of Oxford and Cambridge Board), 2 lessons of ¾ hr., or Domestic Course with Up. V. B. (optional).	*Physiology and Hygiene* and some elementary Biology, 2 lessons. Sense organs, nervous system, sanitation, infection and disinfection, simple experimental work in bacteriology and study of a few biological types.
Chemistry (optional).	*Practical Housewifery and Cookery.*

SPECIAL AND OPTIONAL WORK.

VI. Age 17. (About 16 girls.)	Up. V. Remove. (About 8 or 9 girls.)
Chemistry } (Course for girls	*Science* with Up. V. A. or VI.
Physics } who specialise.)	*Cookery* with Bye Students (optional).
Botany, 2 lessons of ¾ hr. each.	

GENERAL SCHEME OF PRACTICAL WORK IN HOUSECRAFT.

1911.

Lower II., age 9–10. *Needlework.**

1. Canvas and specimen work showing the following stitches—tacking, running, hemming, seaming, blanket stitch, simple fancy stitch, such as chain and herring-boning. Simple darning and easy knitting.
2. Paper-folding and simple patterns.
3. Making up fancy bags and handkerchief cases, &c.

Upper II., age 10–11. *Needlework.**

1. Paper-folding. Simple chemise for child of 5, and plain pinafore. Button-hole stitch and simple embroidery.

Lower III. A. and B., age 11–13. *Needlework.**

1. Paper folding for simple patterns.
2. Garments for child of 5—flannel petticoat, knickers and overall—showing running, hemming, seaming, herring-boning, simple embroidery, tapes, gathers, and buttonholes,
(In Upper II. and Lower III., clothing for a girl of 5 for giving away.)

Upper III. A. and B., age 13–14. *Needlework.**

1. Drafting patterns, and measurements &c. Darning, patching and knitting.
2. All the stitches learnt before are used in the following :—
3. Garments :—Nightdress for child of 7, and complete outfit for a baby.

* The Needlework scheme of Forms I. to Upper III. (inclusive) has been altered considerably for the year 1912-13. Miss Swanson's method of Educational Needlecraft is here followed.

Form IV. B., age 14–15. *Needlework.*

How to make a simple dress. Drafting, cutting out, fitting and making up with the use of the sewing machine.	Short course in elementary Cookery, Laundry and Housewifery, for many of these are girls who will leave school at 16.

Lower V. A. and B., age 15–16. *Cookery, Laundry and Housewifery.*

Cookery—Baking, boiling, frying, steaming, soup-making, &c.

Laundry—Washing woollen garments. Washing and boiling white clothes, starching and ironing. Getting up silks and laces.

Housewifery—Scullery work and general cleaning—silver, knives, brass and scrubbing.

Up to this point the work is compulsory and taken by all the pupils.

Upper V. A. and B. age, 16–17. *Superior Household Cookery and Housewifery.* First aid and sick nursing. Invalid cookery.

Upholstery and Art Needlework.

Bye Students. Superior Household Cookery.

NOTES ON THE SCIENCE COURSE SHOWING THE POINTS OF CONNECTION WITH HOUSECRAFT.

The Science teaching, especially in the middle of the School, is made to bear as much as possible on the things of every-day life without interfering with the continuity of the work. That is to say, illustrations are drawn, wherever possible, from the household and from matters of common experience; but each instance is taken as illustrating some scientific principle or principles, the idea being, as far as possible, to get some ideas of scientific principles and the habit of applying them to the explanation of any problem that happens to arise, *not* to merely give scientific explanations of isolated phenomena, selected on account of their importance in everyday life.

The work begins in First and Second Forms with *Seasonal Nature Study.* Walks are arranged in connection with this, aquaria &c. are kept in the class room, and a great deal of interest has been aroused, leading to some careful independent work at home.

Lower III Forms, Age 12–13.

Elementary Physics:

3 lessons of ¾ hr. for 2 terms.

2 lessons of ¾ hr. in Summer Term.

Botany: 1 lesson of ¾ hr. in Summer Term.

Elementary Physics.—This year's work is designed to give some important fundamental knowledge on which the future work can be built, together with training in manual dexterity.

After the principles of measurement, and the nature of units, standard and otherwise, have been discussed, further practice in measuring lengths, areas and volumes geometrically, is left to the Mathematical mistress. Volumes of liquids and solids by water displacement are measured. Mass and weight are studied, the principle and construction of the Balance are examined. Densities are measured with the density bottle. Familiar substances, such as milk, are taken, and the effect on its density of adding water or removing cream noted, and the use of density as a test of adulteration. Solutions of fixed strength and saturated solutions are made.

The Laws of Fluid Pressure are next demonstrated, and applied to the understanding of the Bradford Water Supply System, to the Bramah Press, &c.

If the class is very intelligent and quick, the principle of Archimedes is led up to and explained by these laws, verified and used for finding densities, and explaining problems of flotation, but as a rule we pass to the consideration of Air Pressure, the Barometer, the common Pump, Siphon &c., and to the verification of Boyle's Law.

Botany.—The one lesson a week in the Summer Term is devoted chiefly to the study of flowers and pollination.

Upper III Forms, age 13–14.
Elementary Physics, Heat, 2 lessons of ¾ hr. each.
Botany, 1 lesson of ¾ hr.

Heat.—The course here follows the usual lines in the elementary treatment of the subject, but in addition to the usual illustrations others are drawn wherever possible from the home. Geographical illustrations are also used to encourage the pupils to give their scientific principles as wide an application as possible.

After some discussion of Heat and Temperature and examination of the Thermometer, expansion is treated. This is very fertile in familiar illustrations. The construction of the thermometer follows, and the examination and the use of the Maximum and Minimum and Clinical Thermometers. Then regarding expansion from the point of view of alteration of density we pass to Convection, and work is done in connection with the heating apparatus of the school, the hot water supply at home, the behaviour of water in ponds on cold nights, ventilation, winds. Cyclones and anti-cyclones, are usually studied here, in addition to those winds obviously caused by differences in temperature. Meteorological Reports and Charts are examined, and some idea obtained of the way in which forecasts are issued. Conduction and Radiation are usually taken next. Many familiar applications are found, among others to clothing, the heating of rooms, methods of cooking. (Convection, of course, comes into the consideration of the last two.)

Specific Heat follows. Household illustrations include the choosing of suitable materials for holding and giving out large or small quantities of heat, *e.g.*, for hot water bottles, tea-pots, &c.

Change of State and Latent Heat yield many applications, for instance, to the testing of purity of materials, to the importance of dry clothing, to means of obtaining low temperature, to means of raising and lowering the boiling point of water, and the consequent importance in cooking and to the behaviour of the moisture of the atmosphere.

Botany.—The work here is chiefly descriptive, but an effort is made to get an idea of the yearly period in the history of British plants. Some plants, such as the Crocus and Tulip, are kept under observation throughout their annual cycle.

IV. Forms, age 14–15.
Chemistry, 2 lessons (2 hrs. or 1½ hrs.).
Botany, 1 lesson of ¾ hr.

Chemistry.—The object in this course is to get some knowledge of the lines along which scientific research is conducted, and to acquire a good deal of information of practical value, especially in relation to the cooking and physiology courses which follow in the Lower V. After a distinction between chemical and physical change has been made, the course continues with a piece of carefully reasoned work on the combustion of Magnesium and Phosphorus leading to definite conclusions as to the nature of "burning" in those two substances, and to some idea as to the nature of air. The observation of fact is made the basis of the work. It is followed by the framing of explanatory hypotheses, and by the testing of these hypotheses, leading in one instance to the establishment of another fact.

When this work has been done, the pupils are in a position to realise that time does not permit of their carrying out all their work along

these lines. They are shown that it is unnecessary when we have carefully authenticated records of other people's work, and their own work now proceeds more along the lines of illustration and demonstration. They are encouraged to frame explanatory hypotheses as they proceed, but are warned against confounding isolated confirmatory tests with rigid proof.

Air, Oxygen, Nitrogen are studied.

Work on Combustion is followed by application to the laying, lighting and maintaining of fires, the means of reviving and extinguishing them, the means taken to obtain a high temperature, explosion, precautions to be taken in using inflammable liquids, and in case of fire, &c.

The acid-forming oxides lead to the common acids (including vinegar, lemon juice, &c.), their properties and their use in the house, *e.g.*, cleaning, removing stains and "fur" left by hard water, &c. Salts are made by the action of acid on metals, their oxides and carbonates. Solution involving chemical change is thus examined and household applications drawn.

Work on Hydrogen and Water ends in a consideration of the properties of good drinking water and its chief sources of contamination.

The study of carbonates includes, beside chalk and limestone with their obvious applications to hardness of water, &c., washing soda and baking soda and baking powder.

Coal and the products of its dry distillation are slightly studied; also coal gas and candle flames, other illuminants and means of obtaining good light.

Vegetable and Animal Fats are then considered and compared with mineral oils. Their use as illuminants and for cooking is taken. Soap is manufactured, and its use in cleaning observed.

Starch, Sugar and Proteid (as shown in meat and white of egg) are studied with a view to their right use in cooking.

Botany.—Some experimental physiology is introduced here. The pupils usually take the Lower Certificate Examination of the Joint Board.

Lower V. Forms, age 15–16.

Lower V. A. Chemistry 2 lessons (1½ hours and 1 hour). Physiology 1 lesson, 1 hour. (Cookery) 1 lesson, 2 hours.

Lower V. B. Physiology, 2 lessons 1¾ hours. Botany, 1 lesson ¾ hour. (Cookery), 1 lesson 2 hours.

Chemistry.—The brighter girls are now anxious to know more of the laws underlying the facts they have observed, and Chemistry in Lower V. A. follows more systematic lines leading to the Laws of Chemical Combination and theories explaining them. We are at present following the course in Lewis's Inorganic Chemistry, Cambridge University Press.

The course in Forms IV. and Lower V. A. is compulsory. After this, facilities are afforded for girls to specialise in Science, either in preparation for a University course, or in connection with Housewifery.

Physiology.—This course is planned to give in broad outline a knowledge of the chief organs of the body, their work, and the conditions which must be fulfilled to keep these organs in as healthy a condition as possible. The skeleton is studied, and the different types of joints, then the composition and circulation of the blood. The changes which the blood undergoes in different parts of the body are studied, and lead to an examination of the structure of the lungs. The study of the respiratory organs is accompanied by consideration of the problems of ventilation, and different methods of ventilating an ordinary room are examined. This is followed by a study of the digestive organs and their work, and of the different classes of food stuffs and their uses (*cf.* Form IV. Chemistry and Upper V. Botany). Attention is directed to the question of diet, and variations in diet, suitable for different habits of life. Sample meals, such as those supplied to the Bradford School children are considered, and the proportions of proteid, carbo-hydrate and fat present are calculated.

The work of the skin is studied, and the conditions necessary to keep it in a healthy condition, *e.g.*, baths, suitable clothing. The need for taking sufficient exercise is generally considered at this point.

Suitable sites for houses, and some of the more important facts about their construction are studied, *e.g.*, drainage, damp proof courses.

A few lessons are given on very simple First Aid, *e.g.*, treatment of cuts, bruises, bleeding from an artery or a vein, artificial respiration.

N.B.—Simple instruction in the laws of health is given all the way up the school in connection with Physical Exercises. Each form has two lessons (½ hr. or ¾ hr.) in the Gymnasium every week.

Upper V. Forms, age 16–17.

Upper V. A. Botany, 2 lessons of ¾ hr. each. Chemistry (optional).

Domestic Course (optional). A few girls take this with Upper V. B.

Upper V. B. "Domestic Science" 2 lessons, 1¾ hrs. Hygiene, 1 hour.

For Senior Oxford Local Examination.

Botany.—The work here is chiefly plant physiology. Special work is done on enzyme action and ferment organisms, such as yeast, and bacteria, infection, disinfection, &c.

Chemistry may be continued by certain girls if desirable. Up to the present term the laboratory fittings were only suitable for the elementary work in Chemistry done in Forms IV. This term, accommodation has been provided for classes doing more advanced work, and the Lower V. course has been begun.

"*Domestic Science*" in this form, this year, follows the syllabus of the Senior Oxford Examination, which must be taken by a few of the weaker Board of Education Bursars, as their "Qualifying Examination," and consists largely of a repetition of much of the work done lower down in the school, but also of a more extended study of general elementary Physics and Chemistry, with special reference to household affairs and everyday life.*

The *Physiology and Hygiene* course is a continuation of the work done in Lower V. B. A further study is made of the impurities likely to be present in air, and the means taken to remove them; also a detailed study of ventilation including artificial methods, and also methods of combining heating and ventilation, *e.g.*, Galton's Ventilating Grate, and examples of ventilating stoves.

A more detailed study is made of matters already touched upon in the Lower Forms. The advantages and disadvantages of different methods of artificial lighting and heating are studied. A detailed study of the different sources of water supply is made, and of the suitability of the water for cooking and cleaning purposes; also a more extended study of food stuffs and diet.

Further work is included on the sanitary construction of buildings, personal hygiene, infection and disinfection.

N.B.—Many of the girls in this form are backward or have entered the school late, and repetition of this important work is advisable.

Form VI., age 17–19.

Physics, 2 lessons of 1 hr. each.

Chemistry, 2 lessons, of 1½ hrs. and 1 hr.

Botany, 2 lessons, ¾ hr.

In *Physics and Chemistry* courses are arranged for girls who are specialising.

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* (To be discontinued in 1912–13.) This has been replaced by a more extended course in Hygiene and Biology. Typical animals and plants are studied.

Botany.—A course is usually given in which a number of vegetable types and their methods of reproduction are studied. This is followed by some study of theories of evolution and laws of heredity.

Note I. on the Botanical Work.

This work is thought to be valuable partly because it satisfies a natural taste in girls, but chiefly because it gives opportunity of actually studying the conditions of healthy life in living organisms, and because it leads naturally to the discussion of important subjects in the last part of the course, that could not well be taken in ordinary class work from the zoological side. In relation to domestic work it is also valuable in giving a fuller knowledge of the character of important food stuffs.

Note II.

If time allows we shall try to introduce some elementary work on Optics and Electricity into some part of the course (probably in Lower IV. for brighter girls, in Lower V.B. for others).

(ii) CLAPHAM HIGH SCHOOL FOR GIRLS.

COURSE OF SCIENCE INSTRUCTION FOR GIRLS BETWEEN THE AGES OF 12 AND 16.

Necessity for Science Instruction.

1. *For the cultivation of a scientific habit of mind*, and the training of various powers that it affords—

(*a*) observation;
(*b*) classification of facts, with their right sequence and relative importance;
(*c*) logical reasoning;
(*d*) imaginative faculties.

2. *The practical utility of its facts in everyday life.*

The chief purpose of the Science instruction for girls under 16 years of age should be the cultivation of the scientific habit of thought, and efficient training in method.

Those who are most aware of the usefulness of many of the facts of Science, are apt to forget this all-important purpose in their anxiety to impart a knowledge of these useful facts; there is a real danger of the educational value of Science being overlooked on account of the obvious practical value of its facts.

It is important to keep quite clear these two distinct aims in Science teaching:—

1. *The cultivation of a scientific habit of mind*—mental training.
2. *The communication of useful facts*—the imparting of useful knowledge.

The teacher whose purpose is the mental training may also impart a large amount of useful knowledge by choosing illustrations from everyday life, though the choice must depend chiefly on the suitability of the fact for the special piece of training in view, not on its practical utility.

On the other hand, the teacher whose purpose is mainly the communication of useful knowledge, of necessity misses the mental training.

In some schools the curriculum may allow both of lessons in Science for the training of a scientific habit of thought, and of lessons in Housecraft for the usefulness of the facts learnt; but in schools where the curriculum will not allow of both, the first is the more important, for the reason that children retain but a small percentage of the facts they are taught at school, the training remains when the facts are forgotten.

Syllabus of Course.

I. *First Year. Age* 12–13. *Time* 80 *minutes per week.*

A. *First Term.*

1. A cube as exhibiting three dimensions. Meaning of length, area and volume. Importance of measurement in Science. Necessity for units of measurement. Selection of unit for length, area and volume.

2. Area of rectangles and parallelograms. (Carpeting, papering, turfing.)

3. Area of triangles and polygons.

4. Volume—a solid cube and a hollow cube which can be filled with shot, sand, water, &c. Graduated jars and burettes. (Medicine glasses, pint measures, peck of peas, &c.)

5. Use of buretter for measuring out volume of liquid, and graduated jars for measuring volumes of stone, &c. by displacement. (Putting potatoes in a saucepan full of water, or fish in a pan of frying fat, &c.)

6. The building up of rectangular solids with unit cubes, and proving the volume of rectangular solid; as area of base × height. (Bricks in a brick wall.)

7. Finding the volumes of prisms by immersion in graduated jars, and in cane with a spout in the side, and verifying the result of lesson 6.

8. Similar experiments with solid pyramids to prove volume of pyramid as $\frac{\text{area of base} \times \text{height}}{3}$.

9. The cube as a quantity of material substance—its mass, measurement of mass. The making of a very simple balance, with which the law of the balance can be found.

10. Exercises with the simple balance. The see-saw.

11. Finding mass with a good balance.

12. Problems such as finding lengths and area by means of weighing.

B. *Second Term.*

1. Cubes of different materials—density as the mass of unit volume.

2. Finding densities of common substances.

3. Further practice in finding densities.

4. Testing materials by finding their densities.

(Real ebony as compared with black wood—ivory and bone—gold and silver—milk.)

5. The cube and its weight. Weight and mass compared and the idea of force brought in.

6. Measuring weight by the stretching of elastic and of home-made springs.

7. The use of a good spring balance—Tension and compression balances.

8. Apparent change of weight when the body is surrounded by other fluids than air.

9. The law of Archimedes—Testing the law with a spring balance.

10. Further testing of the law with different bodies and different fluids.

11. Application of the law to finding volumes.

C. *Third Term.*

1. The law of Archimedes tested with a common balance.

2. Floating bodies; the weight of a floating body is equal to the weight of fluid it displaces.

3. Further exercises on floating bodies. (Testing eggs. Difficulty of frying cakes that float in fat—compare frying fish.)

4. Boats, consisting of water-tight rectangular boxes. Varying the boat-load. Balloons explained with air-balls filled with air and with coal-gas.

5. Weight and centre of gravity. (Opening and shutting windows.)

6. Weight the cause of falling—Importance of position of centre of gravity—Experiments to show that the ease or difficulty with which a body can be upset depends on the position of its centre of gravity.

7. Application to ballast in ships, overloading decks, standing up in rowing boats.

8. The "law of falling over"—Experiments to test the law.

9. Experiments to show the danger of building a leaning tower, of going up a crooked ladder. (Hay carts and coal carts—Omnibus or coach loaded inside or outside—Standard lamps.)

10. Revision—Finding lengths and areas by weighing.

11. The area of a circle and volume of a cylinder.

II. *Second Year. Age* 13–14. *Time* 2 *hours.*

A. *First Term.*

1. Weight—idea of force emphasises. Methods of overcoming weight—The lever.

2. Further experiments with levers—School weighing machine—Chopping knife—Nutcrackers, &c.

3. The pulley; fixed and movable pulleys. Pulleys in use in the school.

4. The inclined plane. (The steeper the hill, the harder to pull a card up.)

5. Friction—Drawing blocks, &c., along different surfaces, with spring balances. (Rollers and wheels.)

6. Attraction and repulsion—magnets—Torsion—Tension.

7. Composition of forces in the same line, or parallel. Experiments with spring balances.

8. Resolution of a force into two components at different angles. (Window poles—a load shared by two people—Towing a boat—Horse pulling railway truck.)

9. Similar experiments and the parallelogram drawn.

10. Three forces producing equilibrium and the triangle drawn.

11. Familiar examples illustrating Newton's first law of motion.

B. *Second Term.*

1. Heat—Description of old ideas as to the nature of heat, and the reasons for the present idea. Water boiled—Glass rod and knitting needle held in the flame.

2. Temperature and the use of a thermometer.

3. The Centigrade and Fahrenheit scales—Change of temperature—Temperature of a body—Boiling point of water, of salt and water. (Quick boiling.) Melting point of ice.

4. The temperature of ice and salt, of salt and water, of sugar and water, of saltpetre and water, of sulphuric acid and water. (Salt to clear away ice and snow.)

5. Freezing water in a mixture of ice and salt and then letting it warm to the temperature of the room, reading the thermometer every minute. Graph of time and temperature. (Making ices.)

6. Melting wax in boiling brine, and obtaining the cooling curve as before. (N.B.—These experiments bring out the fact that the temperature of a substance remains the same whilst it is changing its state.)

7. Experiments to show that temperature must not be confused with quantity of heat.

8. Measurement of quantity of heat, and meaning of the unit. Calculation of the number of calories gained by some water during five minutes heating, and lost by some water during five minutes cooling.

9. Calculation of the heat lost by some hot water and gained by some cold water when the two are mixed. What becomes of the difference?

10. Calculation of the heat lost by metal balls when put into cold water and deduction of the loss per gramme per degree fall of temperature.

11. Similar experiments.

C. *Third Term.*

1. Experiments to find the specific heat of mercury.
2. The heat required to melt some ice.
3. The heat given out when steam condenses.
4. Effects of heat—change of temperature—change of size—expansion of solids—expansion of wire.
5. Expansion affecting pendulum clocks. Experiments with a simple pendulum.
6. Expansion of liquids, using density bottle.
7. Expansion of liquids, using thermometer tubes already filled with different liquids.
8. Expansion of gases; the hotter the gas, the larger it becomes. Trouble with gases because pressure affects the size as well as temperature.
9. The greater the pressure, the smaller the gas.
10. The hotter the gas, the greater the pressure required to keep the size the same.
11. Change of size accompanying change of state. Ice and water. Cast metal.

III. *Third Year. Age* 14–15. *Time* 2 *hours.*

A. *First Term.*

1. Relations between volumes, temperature and pressure of a gas. Charles' Law and absolute temperature. Graph.
2. Boyle's law. Graph.
3. The third law. Graph.
4. Temperature measured with the constant volume air thermometer.
5. Transference of heat—Conduction.
6. Convection.
7. Radiation.
8. The pressure of the air—barometer.
9. The siphon, with special reference to its use in aquaria. The common pump.
10. Air and ocean currents.
11. Clouds, rain, snow, dew, frost.

B. *Second Term.*

1. Light—luminous and non-luminous bodies. Shadows.
2. Illuminating powers compared with simple photometers.
3. Reflection from mirrors—paths of rays marked by pins.
4. Reflection from glass, to prove position of the image.
5. Simple observations on reflection from convex mirrors.
6. Simple observations on reflection from concave mirrors. Formation of real image on a screen.
7. Refraction through a glass plate.
8. Refraction through water.
9. Real and apparent depth.
10. Refraction through glass prism.
11. The colours seen through the prism.

C. *Third Term.*

1. Refraction through convex lens—Real image. Magnifying glasses.
2. Magnetism—The lodestone—The bar magnet—Horse-shoe magnet—Compass. Poles shown with iron filings—Making a magnet by stroking a piece of clock spring.
4. Mapping out lines of force in field round magnet, with compass needle and iron filings.
5. Force which a magnet pole exerts on a small magnet at different distances.

6. Electric current—Volta's discovery with copper and zinc plates dipping in dilute acid. Connecting wire has the power of deflecting a magnet.

7. Other cells giving stronger currents. Insulated wires—Home-made galvanometers.

8. Electric lamp—Iron rod magnetised by a current—Simple electric bell.

9. Conductors and non-conductors of current. Decomposition of copper sulphate to illustrate electro-plating.

10. Electrification of pith balls, with rods of glass and sealing-wax. Electric machine shown—Electric sparks.

11. Lightning and lightning conductors.

IV. *Fourth Year.* *Age* 15–16. *Time* 2 *hours.*

A. *First Term.*

1. Chemical and physical change.

2. Methods of bringing about chemical change; contact, heat, solution.

3 and 4. Further examples of chemical change, *e.g.*, action of heat on wood, meat, coal, &c. Baking powder—Seidlitz powder.

5. Change of temperature produced by chemical change. Heat of the body.

6. Chemical and physical properties of air.

7. Composition of air.

8. Rusting, burning, breathing.

9. Expansion of air in connection with ventilation, heating of ovens, lightness of cakes, &c.

10. Preparation and properties of oxygen.

11. Preparation and properties of nitrogen.

B. *Second Term.*

1. Water—physical properties.

2. Occurrence of water in nature. Different kinds of water.

3 and 4. Distillation, solution, suspension, crystallization.

5. Hard and soft waters.

6. Methods of softening water.

7. Action of sodium on water.

8. Action of iron on water.

9. Preparation and properties of hydrogen.

10. Preparation of water by burning hydrogen in air.

11. Composition of water by weight.

C. *Third Term.*

1. Composition of water by volume, analytically.

2. Composition of water by volume, synthetically.

3. Differences between compounds and mixtures, elements and compounds.

4. The air a mixture.

5. Different kinds of chemical change. Combination and decomposition.

6. Water in everyday life; cleansing, water supply, &c.

7. Carbon, occurrence, different forms.

8. Preparation and properties of Carbon dioxide.

9. Chalk and lime.

10. Carbon dioxide in everyday life; breathing, assimilation, fermentation.

11. Acids, alkalis, bases, neutralization, salts.

RELATIVE POSITION OF SCIENCE AND HOUSECRAFT IN THE SCHOOL CURRICULUM.

A. *Secondary Schools in which the leaving age is* 18–20.

1. Below 12 years of age - - Nature Study and Botany.
2. From 12 to 13 years of age - First Year Science Course. Time—80 minutes per week.
3. From 13 to 14 years of age - Second Year Science Course. Time—2 hours per week.
4. From 14 to 15 years of age - Third Year Science Course. Time—2 hours per week.
5. From 15 to 16 years of age - Fourth Year Science Course. Time—2 hours per week.
6. From 16 to 17 years of age - Housecraft. Time—2 hours per week.

(N.B.—The Housecraft may be instead of, or in addition to other Science lessons, and may be omitted by girls who propose to take a post-school course.)

B. *Secondary Schools in which the leaving age is* 16.

From 12 *to* 15 *years of age*, a modified Science course; with the third year Science is omitted, and the fourth year course taken from 14 to 15 years of age.

From 15 *to* 16 *years.* Housecraft course.

C. *Post-school courses.*

1. Housecraft's certificate course, covering a period of from one to two years. The aim is to fit girls for management of home, or in the case of the two years' course, to train them as professional housekeepers or matrons.

2. Three years' course for training teachers of Housecraft in Secondary Schools.

SEVEN YEARS' NEEDLEWORK SCHEME.

Form.	Article.	Materials.	Drafting.	Cutting.	Fixing.	Sewing.
Kindergarten Lower I. 1 hour.	Knitted reins, cuffs, bonnets, &c.	Wool, bone needles.	—	—	—	Plain and purl knitting.
Upper I. 1½ hours per week.	Shoe bag, mat.	Casement on alpha cloth, coarse embroidery cotton.	Full size.	Full size.	Hems and fold for seaming.	Running, tacking, sewing.
Lower II. 1½ hours per week.	Tie Case, Handkerchief case.	Casement on alpha cloth, coarse embroidery cotton.	Full size.	Full size.	Hems, folds for seaming.	Running, tacking, sewing, hemming, loop stitching, chain stitching.
Upper II. 1½ hours.	Pinafore, seamless.	Casement or alpha cloth.	½ size.	Full size.	Hems, sew, and fell seams, tapes.	As previous grade, stitching, sewing on buttons and tapes.
Lower III. 45 minutes.	Petticoat or bed jacket, embroidered collars and fronts.	Flannel.	Full size.	Full size.	Hems, seams placket opening, pleating.	As previous grade, herring-boning, loop stitch

Form.	Article.	Materials.	Drafting.	Cutting.	Fixing.	Sewing.
Upper III. 45 minutes.	Small overall.	Print, zephyr.	Full size.	Full size.	Hems, French seams, back opening, stroking, gathers button-hole.	As previous grades, gathering, feather stitching, and other ornamental stitches. Button-hole stitch.
Lower IV. and Middle IV. 45 minutes.	Camisole, child's princess petticoat and yoked pinafore.	Long cloth.	Full size.	Full size.	Run and fell seams, hems, stroking, gathers, tucks back opening, false hems.	As previous grades, whipping on embroidery, tuck running.
Upper IV. Lower V. 45 minutes.	Blouse, unlined skirt.	—	Full size simple blouse skirt, ½" scale.	Full size.	French seam, setting on collar, setting in sleeve, placing together skirt for machining.	Overcasting, machining, ornamental stitches for embroidering blouse.

APPLIED SCIENCE COURSE TAKEN AFTER THREE YEARS' SCHOOL SCIENCE COURSE.

Water

Composition, Methods of softening water for domestic use.

Experiments with regard to efficiency and relative softening power of soap, soda, borax, ammonia, bran, &c. Calculation of Cost.

Steeping. Its use in the household in economizing time, labour and material.

Solvent power of water solutions, &c.

Study of Acids, Alkalis, Salts -

The cleansing of different materials and household objects, removal of stains. The making of soap, aerated waters and baking powders, &c.

Investigation of cleaning materials, scourers, cleansers, polishers, grease absorbents.

Selection and application of various household cleaning materials to suit different surfaces and to remove various dust combinations.

Air.

Composition, properties, &c. -

Ventilation, respiration, circulation, oxidation.

Heat.

Expansion, change in size of solids, liquids and gases.

The cracking of glass and china, the bursting of pipes, freezing mixtures, the boiling point of solutions and various liquids, effect of pressure evaporation.

Heat—continued. Transmission of Heat, Conduction, Convection, Radiation.	Thermos flasks, ice chests, Norwegian Cooking stoves. Hot water supplies. Management of Stoves. Heating Ovens, Draughts, Chimneys, &c. Good and bad radiators and absorbers. Choice of kitchen utensils.
Transmission of Heat applied to various Cookery Processes. Use of Thermometers.	1. Baking, roasting and grilling. 2 Boiling, steaming, stewing and frying.
Solvent power of water at different temperatures.	Methods of extracting the soluble constituents of meat, fish, bones, &c.
Eggs, composition, effect of heat.	Various methods of cooking eggs, omelettes, &c. Use as a raising agent.
Milk. Composition, relative density of fresh milk, cream, and skimmed milk, clotting and curdling, use of barley water, lime water, and whey as diluents.	Milk Jellies, junket, sterilizing and pasteurizing, preparation of food for infants.
Elementary study of starch, structure of grain. Chief characteristics, effect of heat, gelatinizing point, various powders.	Making Sauces, Starch Moulds and Puddings. Use in Laundry work.
Flour Gluten separated, effect of heat, absorptive power of different kinds of flour.	Making scones, cakes, pastry.
Sugars, conversion, effect of heat	Syrups, caramel, &c.

POST SCHOOL COURSE.

Syllabus for Elementary Housewife's Certificate.

Time for Training, 1 year and 1 term.

Average number of hours, 950.

Chemistry of the Household.—150 hours.

The balance method of weighing—Density—Pressure of liquids.

Principles underlying water supply of houses.

Water.—Its occurrence—Impurities and purification. Chemical composition—Solutions and solubility—chalk lime and carbon dioxide—Hard and soft waters—Distillation.

Effects of heat and cold. Boiling point under various conditions. Latent heat.

Air.—Composition—Impurities—Atmospheric pressure—Barometers—Properties of gases—Respiration—Ventilation.

Fire and Fuel.—Chemistry of a match—Building a fire—Heating and lighting—Value of solid, liquid, and gaseous fuels. Stoves suited to each. Principles underlying the construction of grates, lamps, &c.

Heat.—Conduction—Convection and radiation. Effects of Heat, Expansion—Melting—Evaporation—Capacity for heat. Measurement of heat and temperature—Thermometers—Simmering—boiling, steaming.

Chemistry of Light.—Chemistry of a candle—Paraffin lamps. Coal gas — water — acetylene gas — metres — burners — explosions — Safety lamps. Flash point of different oils

Cleaning.—Sources of dirt—Dust and its removals—Stains—Effect of alkalis, acids, salts, methods of softening water—soaps—manufacture and

varieties—action on water—Washing powders. Cleansing agents—Soda—Ammonia—Borax. Naphtha—Paraffin—Bath brick, &c. Grease solvents. Cleaning metals, wood, &c.

Chemistry of the Laundry.—Structure of fibres. Action of water and soap on fabrics. Preservation of colour, bleaching and disinfecting. Removal of stains—Solvents—Absorbtion methods. Treatment of delicate fabrics.

Food and its functions. Chemical change—The source of heat and energy. Vital temperature—Oxidation—Classification of foods. Composition and dietetic value. Effect of cooking.

Starch and Sugars.—Structure of starch grains. Nature of Starch. Use—effects of heat—methods of cooking—Cane Sugar—Grape Sugar—Milk Sugar—Digestion of sugars and starches.

Milk.—Natural, condensed, dries. Clotting and curdling. Use of barley water and lime water in preparation of wood for infants and invalids.

Eggs.—Food value and composition—Temperature of coagulation. Their use as a medium for introducing air into mixtures. Methods of cooking.

Chemistry of Baking Powders.—Soda—Cream of Tartar—Phosphates—Alum, yeast, alcohol, &c. Chemistry of bread-making.

Fats and Oils.—Digestion and function of fats as foods. Animal and vegetable fats. Effect of heating-temperature at which they smoke. Use in cakes and pastry.

Nitrogenous Foods.—Proteids—Canned meats—eggs. Casein, Gluten, use as food—effect of cooking—methods of extracting and retaining soluble constituents of meat and fish. Digestion.

Preservation of Foods.—Elementary study of yeast, moulds and bacteria. Methods of preserving food by addition of germicide. Exclusion of air. Withdrawal of water, heat, and cold.

Elementary Cookery.—230 hours; 30 Lectures. 200 hours; Practical Work.

First Term.—Care and management of stoves. Choice, cleaning and care of cookery utensils. Choice of Food. Methods of baking, roasting, frying, grilling, boiling, and stewing meat and fish. Cookery of vegetables. Stock-making and soups.

Second Term.—Further practice in the principles underlying the first term's course. Breakfast dishes—bread, cakes, pastries, and puddings. Cold meat cookery. Pulse foods.

Third Term.—Salads and salad dressing. Foods for infants and invalids. Preserving food and potting meat. Pickling. Good supper dishes. Jelly making. Cheese cookery. Simple icing and piping. Carving. Drawing up menus. Cooking and serving simple dinners at given cost.

Laundry Work.—100 hours; 20 Lectures. 80 hours; Practical Work.

Sorting, removing stains and preparing clothes for the Laundry. Keeping washing accounts. Preparation of Laundry Materials and Utensils.

Making starch, soap, jelly, &c. Washing and getting up white linen, cotton and flannel garments.

Second Term.—Further practice in above processes. Cold water starching. Washing and finishing household linen. Action of bran water. Washing and finishing silks—cretonnes—prints, &c.

Third Term.—Washing and finishing lace—chiffon—embroideries and delicate fabrics—further practice in previous work.

Household Management.—120 hours, 30 Lectures. 90 hours, Practical Work.

First Term.—Duties of a Housekeeper. Division of income. Choice of a house. Arrangement of housework. Daily and weekly routine. Work and management of servants. The practical cleaning of household utensils. Making polishes and pastes.

Second Term.—Practical cleaning and turning-out of rooms, hall, staircase, &c. Cleaning marble, paint, furniture, carpets, linoleums, &c. Choice, care and cleaning of bedding. Choice of the larder. Marketing. Rules for furnishing, choice and price of utensils. Care and management of the linen cupboard.

Third Term.—Further practice in the previous term's work. Table decoration, &c. Household accounts. Weekly books. Hints on banking. Dealing with cheques. Post Office Savings Bank transactions. Investments and dividends and how to record them. Advantageous outlay of different sums of money.

Physiology and Hygiene.—40 Lectures of 1 hour. 20 hours, Practical Work.

General anatomy of the body. Tissues, organs. Elementary study of the circulation, respiration, digestion, &c.

Food.—Composition; diets for infants, adults, and old age.

Air.—Purification, ventilation; amount required.

Water.—Source; contamination, purification.

Soil.—Conditions affecting health, drainage, aspect, and elevation.

Houses.—Choice; causes and prevention of damp; removal of waste and impurities.

Personal Hygiene.—Care of the body; use of soap, baths, rest and sleep; habits, exercise; choice and care of clothing.

Disease.—Its cause and prevention. Prevention and spread of tuberculosis. Use and abuse of antiseptics, disinfectants, deodorants.

Law.—General outline of London Public Health Act as far as it relates to occupiers of a house; its sanitary state. Notification of infectious diseases; nuisances. Powers of the individual to make complaints to sanitary authorities.

First Aid and Home Nursing.—20 Lectures.

St. John Ambulance Association.

Dressmaking.—30 lectures. 90 hours' practical work. Practice in taking measurements for Guerre System of drafting. Adaptation of bought patterns to block pattern. Cutting sleeves, collars, yokes, &c., from block pattern. Stitches and processes used for Dressmaking. Making a simple blouse and skirt. Renovation of worn garments. Lecture on choice of materials. Form, line, colour.

Practical Work for Examination. Blouse, Skirt, and Garment Renovation.

Household Sewing and Mending.—30 Lectures. 90 hours' Practical Work.

Stitches and processes used in plain Needlework. Drafting and cutting-out undergarments and children's clothes by (1) Guerre System. (2) Paper-folding. Choice and price of materials used. Patching, darning and utilisation of garments. Mending gloves.

Practical Work.—Small flannel sampler showing stitches and processes used in flannel garments. Small calico sampler showing stitches and

processes used in calico garments. Small Linen sampler showing patches, darns, marking, hem-stitching, &c.

1 Handmade Cotton Garment -
1 Handmade Flannel Garment - } Choice of Article to be left to
1 Machine-made Garment - } Student.
Embroidery and Applied Design -

Summary of Hours.

Divinity	30
Chemistry	130
Cookery	230
Laundry	100
Housewifery	120
Dressmaking	120
Needlework	120
First Aid and Home Nursing	40
Hygiene, &c.	60
Total	950

2. WOOD-WORK AND METAL-WORK.

(i) SYLLABUS OF WOOD-WORK FOR COUNTRY OR SMALL ISOLATED SCHOOLS (BOYS 11-13 OR 14 YEARS OF AGE).

(Supplied by Mr. JOHN BERRY, Instructor of Handwork, &c. under the Leeds Education Committee.)

Two years' course of models to be made without planes, and without special benches. Can be done at the desk, and without disarranging the other classes or the general arrangement of the school; with the exception of a little sawing will be almost as quiet as the ordinary lesson. The sawing out of the material for each model from the board is the only noisy part. I believe each boy should saw out his own, but in any school some little convenience will be found to enable him to do this without annoying the others.

Material.

The wood must be of good quality, and such as is fairly easy to work. It should be supplied in boards, planed to thickness; in boards, because then the child gets out his own material; planed, because two surfaces are quite enough for a boy to get up each time, before he begins the construction or making proper of the model.

Equipment necessary.

A good firm stool to be used as a sawing bench.

Two hand saws, one cross cut and one half rip—these for sawing out the material.

A Sloyd knife for each boy (the best knife possible). A poor knife means disappointment all the time it is being used.

A 12″ steel ruler for each boy. The boy needs it specially as a straight edge to try up his work.

A small try-square for each boy.

A gauge for each boy.

A half-inch firmer chisel for each boy.

A dovetail saw for every two boys.

A half round file about 8″ long for every two boys.

A few prickers—various sizes.
One brace and a few bits.
Half dozen firmer gouges about ¾″ wide ←¾→

Two or three small hammers, and ½″ oval wire brads.
One good oilstone. Sandpaper, medium and fine.
One bench hook for each boy, for sawing and cutting on at his desk
Whole equipment approx. 10*l.* for 20 boys, about the cost for two boys in ordinary centre.
No special room required.

The Boys at Work.

(Incidentally I do not see why girls should not do something in this way. I believe they could do the first year's course equally well with boys.)

Before the lesson the teacher lays out the tools and the models on a table before the class. Each boy takes up the necessary tools and his model, goes to his desk, and at once begins work. (If he has no model he saws out the material for one.)

In an ordinary way no boy needs in the first year to have more than a knife, rule, and try-square. The other tools are only used for some special feature, and only used occasionally.

The models are made by reference to drawings and models—picture drawings with the main dimensions on them. Certain parts, *i.e.*, curves, are best done to please the eye, the teacher of course giving the suggestion.

The demand for finish must be the boy's best, but he must not be unduly taxed or worried for this.

In the second year a boy needs knife, rule, try-square, chisel, and dovetail saw. Extra tools for occasional use: file, pricker, brace and bit, gouge, and hammer.

The drawing should now be simple orthographic projection (two views generally sufficient) with parts slightly shaded; the model to be made from drawing with occasional reference to model.

Sandpaper.—Often very much abused; a very necessary material. A good teacher will only allow it to be used when a certain stage is reached, and then limit the amount. My limit is not more than 2½″ square for any model.

First-Year Course.

1. Pen holder, to be made from ⅜″ yellow pine.
2. Plant label, to be made from ¼″ red deal.
3. Parcel carrier, to be made from ½″ canary wood, *or* lime, *or* birch.
4. Window wedge to be made from ¾″ red deal.
5. Plant stick, to be made from ⅜″ yellow pine.
6. Straight edge and ruler, to be made from ¼″ canary wood *or* lime.
7. Line, winded, say, for fishing line, to be made from ¼″ canary wood *or* lime.
8. Door button, to be made from ¼″ birch, *or* canary, *or* lime.
9. Paper knife, to be made from ¼″ birch *or* lime.
10. Model of own conception, to be made from any of the above woods.

Tools used in making the above:—Hand saw for sawing out, Sloyd knife, steel ruler or straight edge, try-square, file, pricker, rose-bit.—Sandpaper.

Second-Year Course.

1. Tip-cat *or* piggy, to be made from 1″ red deal.
2. Candle holder *or* test tube holder, to be made from ⅜″ red deal.
3. Pair of set squares, to be made from ¼″ canary *or* lime.
4. Round ruler, to be made from 1″ red deal *or* canary wood.

5. Garden dibble, to be made from $\frac{7}{8}$" red deal.
6. Pan stand, to be made from $\frac{5}{8}$" yellow pine.
7. Picture frame, to be made from $\frac{3}{8}$" canary.
8. Tooth-brush rack, to be made from $\frac{1}{4}$" canary *or* lime.
9. Small boat, to be made from $1\frac{1}{2}$" square section yellow pine.
10. Model of own design, to be made from any of the above woods.

Tools used for making the above models:—Hand saw for sawing out, Sloyd knife, steel ruler, try-square, file, pricker, dovetail saw, gauge, firmer chisel, brace and few bits, hammer, gouge, bench hook for sawing and cutting on, and oilstone for rubbing up the tools.

(ii) CENTRAL SECONDARY SCHOOL, BIRMINGHAM.

The normal School course is one of four years, that is from about 12 to about 16; some pupils stay beyond this course, some enter before 12, but in both cases the numbers are comparatively small. Ordinarily the numbers may be taken as Preparatory 20—1st year 80, 2nd year 80, 3rd year 60, 4th year 35, ex-4th year 7. In the 3rd year of the School course a division is made into a Chemical side and an Engineering side; the difference between the two sides is that in the first some seven or eight periods per week are devoted to Chemistry, in the 2nd the same number are devoted to Engineering subjects, viz., Machine Drawing, Applied Mechanics, and Steam.

In accordance with this general scheme of School work, the manual instruction follows a four-year course of two periods per week: 1st year Wood-work, 2nd year Iron-work; Chemistry side: 3rd year Wood-work, 4th year Wood-work and Instrument making; Engineering side: 3rd year Iron-work (and Pattern making), 4th year Iron-work. Owing to the limited accommodation in the workshop for Instrument making, those whose ability in manual work is below the average are not able to enter. The scheme of work in the different workshops may be taken as under, although naturally, alterations are constantly being made:—

1st Year of School Course.—1st Year of Wood-work.

In every case a careful drawing to scale is made of the object or model to be done, and this has to be signed by the instructor before the actual practical work is proceeded with. A short demonstration or lecture on the materials or tools used is given by the instructor from time to time according to the general nature of the work of the class. [These cannot well be given quite systematically, that is before each particular exercise, because in manual work, perhaps more markedly than in other subjects, the rate of progress of different boys varies very greatly, and some boys may be doing Exercise 8 when others have not finished Exercise 2.]

When the exercise has been completed by the pupil it is brought to the instructor, and if satisfactory is passed, and the pupil proceeds to the next exercise—if not satisfactory it must be redone. From the outset great emphasis is laid on accuracy in work, its necessity is so much more evident to the boy in manual work than in, say, French or History, that its enforcement is of the utmost importance. The actual exercise completed by the majority of the pupils in the 1st year in the course at present in use is as under:—

Object.	*New Wood-work Exercise.*	*New Tools used.*
1. Rectangular prism -	Measuring and planing	Rule, saw, pencil, and square.
2. Plant label - -	Oblique sawing, chiselling.	Chisel.
3. Luggage label -	Vertical paring.	

Object.	*New Wood-work Exercise.*	*New Tools used.*
4. Pencil sharpener (wood with semi-circular ends and sandpaper).	Semicircular paring	Wood compasses.
5. Rule	Gauging, chamfering, and marking.	Gauge and marking knife.
6. Set squares	Planing oblique end, grain.	Set squares.
7. Finger plate	Shaping to design and chamfering.	Pencil gauge.
8. Small bracket	Trenching and nailing	Hammer.
9. Plant stand	Spacing and nailing	Dividers.
10. Pot stand	Halving exercise and eclipse paring.	Spokeshave.
11. Tooth brush stand	Boring and shaping	Brace and bits.
12. T-square	Rebating and screwing	Rebate plane and countersink bit.
13. Watch-stand	Designing and shaping	Scribing gouge.
14. Large bracket	Straight and cross trenching.	Moving bevel.
15. Test tube stand	Chamfering.	
16. Bench sawing board	Dovetail trenching, and turning.	Lathe.
17. Match box stand	Mortice and tenon joint	Mortice chisel.
18. Soap box	Oblique trenching	Paring gouge.
20. Soap box	Dovetailed corner joint	Dovetail saw and marking point.
21. Picture frame	Halving joint, stopped rebate, and chamfering.	Chamfer plane.
22. Nail box	Square sawing and nailing.	Smoothing plane.
23. Inlaid tray	Inlaying and mitreing	Bevel edge chisel and mitre cut.
24. Pen rest	Fluting and trenching	Fluting plane.
25. Ink stand	Stop gouging	External ground gouge.
26. Pen rack	Straping and sinking	Bow saw and spokeshave.

As many pupils in their first year have already done Wood-work at the Wood-work centres for the Elementary Schools, some may not be required to do all the earlier exercises.

2nd Year of School Course.—1st Year of Iron-work.

In Iron-work the necessity for accuracy is even more evident than in Wood-work, at the same time it is more easily attained. All boys start at vice work, but soon after the start lathe work alternates with that done on the vice, this chiefly for convenience in the accommodation, so that the whole set shall not require to be working at lathes at the same time. The scheme of work, however, may be considered as (1) vice work, (2) lathe work.

Vice Work.—The first set of exercises involves training in the filing of a plane face, straight edges and angles of any desired magnitude. Four to six such exercises would normally be finished. As a typical example of this stage the following may be taken: A sheet of ¼-inch mild steel is first marked into a regular hexagon, it is then chipped roughly on the outside and filed accurately to shape. A piece is removed to leave a blank in the shape of an equilateral triangle—this must be done by drilling and finally filing to gauge. A new piece of similar steel is taken and filed to an equal equilateral triangle which must fit accurately into the space, *with each angle inwards.*

Lathe Work.—Alternating with the vice work are simple lathe exercises; such as those enumerated below:—

1. Plain cylinder accurately turned parallel to gauge.

2, 3. Stepped cylinders; introducing facing and collar work.

4. A collar pin made accurately to gauge, not only as regards diameter but also for thickness of collar.

Machine Tool Work.—A simple shaping machine exercise is also introduced in the first year as under. A gauge is first made as a vice exercise, and then a solid block is shaped in the machine to fit the gauge for length, breadth, and thickness. Two holes are drilled in this: (1) a ½-inch template, and (2) a ½-inch tapping. After the hole is tapped a cylinder is turned to fit the ½-inch template hole, and one end of it screwed with stock and dies to fit the tapped hole.

The above is sufficient for a good average boy. Some who show distinct ability are able to do more work than this; for these additional examples of similar type but increased difficulty are set.

3rd Year of School Course.—Chemistry Side.

The work is chiefly an extension of the previous Wood-work, but involves the use of more varied kinds of wood, and necessitates more combination of turned and flat work. Boys are allowed to some extent to design and make their own models after approval by the instructor; in all cases a careful scale drawing is first made. The nature of the work may be gathered from the list of articles commonly made at this stage.

Small bridge for balance (of density work), test-tube stand, photographic plate rack, photographic printing frame, electric bell boxes, burette stand, galvanometer stand, specimen boxes, chessboard.

A few fourth-year boys will also be working at Wood-work. As the more capable boys are working on the instrument-making workshop, those who remain in the workshop would not be more advanced than the better workers of the 3rd year, and their work is of the same character.

3rd Year.—Engineering Side.

In the Engineering side, half the time devoted to manual work in the 3rd year is given to pattern making. This work involves a number of new ideas to the boy, and has been found to be of much value. The patterns are made, coloured in the customary manner and castings in lead are made from a number of the patterns, sand moulds being employed. The following list illustrate the type of exercise given in this work. Patterns for:—Shaft bearing, lathe rest, shaft coupling and core box, crank and core box, gland and core box, plumber block and cap, shaft bracket, wheel, bent pipe, face plate.

3rd and 4th Year of School Course.—Engineering Side.

One half of the 3rd year manual work is spent in the Carpenter's shop at pattern making, and the work is dealt with under Wood-work. The other 1½ years' manual work is spent in the iron shop. The vice and lathe work are now more correlated, the former being largely the making of templates which the work turned on the lathe have to fit. As an example, an exercise would be the turning of a piece of three different diameters, with corners turned, to fit a radius gauge previously made by file on the vice. Such radius curves are afterwards applied in the construction of various forms of handles, for which in every case the template is first made.

Exercises are also given consisting of various combinations of cylindrical and conical forms which necessitate the swivelling of the top rest of the lathe to definite angles. Coupling nuts afford useful combinations of file and lathe work in the same piece. To afford practice in working to different systems of units, some exercises are marked in inches, others in centimetres.

Exercises of a higher grade of difficulty are set for the shaping machine, such exercises introducing correlated work on vice, lathe, and shaping machine. For example, a gauge is made to given dimensions in the vice; a block of cast iron is shaped to fit the gauge for length, breadth, and thickness, and a conical hole is then drilled which shall fit accurately a conical piece previously turned on the lathe.

As another example. An accurate equilateral triangular gauge is made on the vice from ¼-inch steel sheet; then a cylinder is turned on one end of a block of metal and worked to a spherical handle, and the other end is shaped to an accurate concentric equilateral triangle which must fit in all its three positions into the previously made gauge.

Various other exercises are set of a similar nature, all making essential high degree of accuracy, and necessitating the use of various tools.

4th Year of School Course.—Chemistry Side.

Instrument making.

Fourth-year boys working in the Chemistry side do their manual work in a small well-fitted workshop specially intended for instrument making. In this workshop the work is very varied, and introduces work with wood, iron, brass, soldering, &c. The first exercises are set in order to familiarise the boys with filing, turning of brass, and screwing by hand in the lathe, and by screwplate. When familiar with brass-work he commences a piece of apparatus such as, *e.g.*, a tangent galvanometer which entails wood turning and polishing, the making of levelling screws, terminals, magnetic needles, the winding of the coils, the general erection of the parts, and the lacquering of the metal.

Other pieces of apparatus frequently made are, meter bridges, electric bells, brass pushes, plug keys, resistance boxes, various forms of switches, Morse keys, medical coils and larger induction coils, gyroscopes (from rough castings taken from the boys' own wood patterns), Wrinshurst electric machines, small electric motors or dynamos (one boy successfully made a 4-pole ¾-h.p. motor), lantern, &c.

(iii) SEXEY'S SCHOOL, BRUTON, SOMERSET.

SYLLABUS OF WOOD-WORK AND METAL-WORK.

A Two-Year Course in Wood-work.

Throughout the Course, opportunities arise at various points for extra practice of earlier exercises.

When it is found that a particular model presents difficulties, alternative models are introduced, until the necessary skill is attained.

The use of *italics* indicates the first introduction of any particular tool operation.

Lesson 1.—Explanation of the English and metric measures of length. Practice in using same.

Lesson 2.—The principle of orthographic projection. Drawing of block in plan and elevation.

Demonstrating concretely, plane surface, line, edge, face and point.

Exercise 1.—*Planing, Gauging, Squaring, and Sawing.*

E.g., Saw off blocks of various sizes, using wood 10″ × 1½″ × ¾″, showing incidentally that the saw-cuts involve loss of length.

(N.B.—These blocks can be utilised in the Science Laboratories.)

[From this point, it is assumed that the pupil prepares his wood (planing, squaring, &c.) from the rough for each model and exercise.]

Model 1.—Operations involved:—

Shooting with the grain, *paring* both horizontal and vertical, and *boring*.

E.g., Plant Labels.

Exercise 2.—*Grooving.*
Make $\frac{3}{8}$" grooves in wood $10\frac{3}{8}$" × $1\frac{1}{2}$" × $1\frac{1}{4}$".

Model 2.—Recapitulation.
E.g., one or both of the following:—Garden Stake, Tent Peg.

Lesson 3.—The characteristic appearance (grain, &c.) of the various woods that have been used up to this point.

Model 3.—Half lap joint.
E.g., Pan Stand with varied ends.

Note.—In this and succeeding models, opportunity is given for the exercise of the boy's power of self-expression, by allowing him to vary slightly the design.

Lesson 4.—Chisels.

Model 4.—Application of half lap joint, *e.g.*, Kite String Winder. (Ends designed by boys.)

Lesson 5.—Methods of fixing and joining used in Wood-work (nails, screws, glue, &c.).

Model 5.—*End Shooting.*
E.g., Cord Tightener, { and / or } Butter Pat.

Lesson 6.—American Whitewood.

Model 6.—*Nailing.*
E.g., Flowerpot Stand (feet designed by boys).

Exercise 3.—Narrow flat grooving on wide wood, *e.g.*, wood 10" × $2\frac{1}{2}$" × $\frac{3}{8}$"

Lesson 7.—Developments in drawing.

Model 7.—*Housing.*
E.g., Silk Winder, Reel Stand, Bracket, Balance Table (for Science Laboratories).

Lesson 8.—Hammers.

Model 8.—Tee-halving joint and *ripping*, *e.g.*, Seed Guard.

Lesson 9.—Mallets.

Model 9.—*Bowsaw* and *spokeshave* work, *e.g.*, Egg Stand (Legs designed by boys).

Lesson 10.—Planes.

Lesson 11.—Sections in Drawing.

Model 10.—Spokeshaving in *concave* and convex curves, *e.g.*, Ping-pong Bat.

Model 11.—*Rounding* on edge, *e.g.*, Brush Rack.

Model 12.—*Cylinder*, *e.g.*, Rounders Stick, Cricket Stumps, Rolling Pin.

Lesson 12.—Gauges.

Model 13.—*Long Grooving*, *e.g.*, Postcard Rack (ornamental shaping designed by boys).

Lesson 13.—Grindstones and oilstones. Methods of use and manufacture, &c.

Model 14.—Recapitulation, *e.g.*, Elliptical Mat ($\frac{1}{2}$" thick and rounded).

Exercise 4.—Angle bridle joint.

Lesson 14.—Isometric projection.

Exercise 5.—Grinding and sharpening chisels.

Lesson 15.—Sharpening and setting planes.

Model 15.—*Glueing* and *fixing*, *e.g.*, Letter Rack (shaping designed by boys).

Lesson 16.—Northern Pine.

Model 16.—Planing of *wide surfaces, e.g.*, Box (for seed or for Science Laboratories).

Lesson 17.—Satin Walnut.

Model 17.—Centre bridle joint, *e.g.*, Coat Peg.

Lesson 18.—Oblique Projection.

Model 18.—Recapitulation, *e.g.*, any model suggested by boys which has similar but not more difficult tool operations than in the foregoing models.

Lesson 19.—Broad leaved trees and needle leaved trees.

Model 19.—Spokeshaving in *large curves, e.g.*, Coat Hanger.

Lesson 20.—Oak and Larch.

Exercise 6.—Dovetail halving joint.

Lesson 21.—Saws.

Model 20.—*Large flat surface jointing* and *countersinking, e.g.*, Sawing-board.

Lesson 22.—Felling and converting timber.

Model 21.—*Oblique* housing and complex fitting, *e.g.*, Pen Tray.

Lesson 23.—Ash and Beech.

Exercise 7.—Mortice and tenon joint, with square tenon.

Lesson 24.—Mechanical principles of tools (1st part).

Model 22.—*Edge* jointing, *e.g.*, Match-box Stand.

Lesson 25.—Mechanical principles of tools (2nd part).

Model 23.—Recapitulation, *e.g.*, Bracket. (Shaping designed by boys.)

Lesson 26.—Observation of the various parts in a cross section of a timber tree.

Exercise 8.—Stopped dovetail halving joint.

Lesson 27.—Growth of a tree.

Model 24.—Application of dovetail halving joint, *e.g.*, Towel Roller.

Lesson 28.—The selection and defects of timber.

Exercise 9.—Mortice and tenon joint.

Lesson 29.—Black Walnut and Sycamore.

Model 27.—*Gouging* and *sinking*.

Lesson 30.—By-products of timber.

Model 28.—Application of mortice and tenon joint, and rebating, *e.g.*, Mirror, Picture or Photo Frame.

Lesson 31.—Geographical distribution of timber.

Model 29.—Recapitulation, *e.g.*, Book Rest (morticed joints), Thermometer Stand for thermometers made in Science Laboratories.

A Two Year Course in Metal-work.

A.—*List of Exercises.*

1. Gauging. B.W.G.
2. Bending, twisting and cutting wire.
3. Filing.
4. Cutting with chisel.
5. Scribing.
6. Cutting with shears.
7. Drilling.

8. Soldering.
9. Brazing.
10. Forging:
    (*a*) drawing and pointing.
    (*b*) bending at red heat.
11. Punching, riveting and clinching.
12. Seaming.
13. Annealing.
14. Tempering.
15. Bending sheet steel.
16. Sawing iron and steel.
17. Screw-cutting (stocks and dies).
18 and 19. Upsetting and welding.

B.—*List of Models.*

1. Crucible triangle (iron wire and clay pipes).
2. Brass scriber (brass wire, No. 9).
3. Gardener's label (zinc).
4. Set squares (brass).
5. Round sponge-box (zinc).
6. Surveyor's arrow (iron ¼-inch rod).
7. Boy's hoop crook with brazed ferrule (iron wire, No. 4).
8. Fencing staple (iron wire, No. 4).
9. Funnel and handle (tin).
10. Small bucket (sheet iron).
11. Stove rake (iron).
12. Calorimeter (copper).
13. Engineer's straight edge (hoop steel).
14. Specimens of tempered steel (steel).
15. Nut gauge (sheet steel).
16. Hard chisels, chipping and cross-cut (cast-steel).
17. Mincing knife (sheet steel).
18. Plumber's hook (plate steel).
19. Garden trowel (sheet steel).
20. Try square (iron and steel).
21. Calipers, inside and out (sheet steel).
22. Letter-weight (iron).
23. Bolts, nuts and washers (iron).
24. Door-handle (iron).
25. Retort stand (iron).

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3. LIGHTER BRANCHES OF HANDWORK, INCLUDING LIGHT WOOD-WORK.

(i) OUTLINE OF A SYLLABUS OF WORK IN PAPER AND CARD-BOARD MODELS FOR PREPARATORY AND SECONDARY SCHOOLS.

(Supplied by Mr. R. C. CHEVALIER, M.A., Manchester Grammar School.)

For Secondary School purposes the construction of two and three dimensional paper models should be very closely correlated with the other mathematical work. In fact it should form a vital part of the Mathematical Course.

On no account should a definite time be set apart for it each week, but it should be taken when the circumstances call for it and not otherwise.

This being so, it will be understood that the following syllabus is supposed to form part of the general Mathematical Syllabus. For convenience it is divided into Sections and in each Section—by reference to other mathematical work—indications are given showing how it is intended that this syllabus should be dovetailed into the general scheme.

The constructive work in the first two Sections may appear to be rather too simple. No doubt very young children could be made—with the help of elaborate directions—to construct quite complicated models, but the work would not be in any degree heuristic. Here it is understood that the constructive work is done with the minimum amount of help from the teacher.

Section I.

Arithmetic: Simple quantities (whole numbers).

Here, nothing very difficult should be attempted, attention being paid chiefly to manual dexterity.

Rectangular solids:—

The open box.
The closed box.
The box with a lid.

These should be first exact copies of standard models—afterwards they should be constructed (i) to have given dimensions (whole numbers of inches), (ii) to enclose a given number of inch cubes.

Paper ruled in inch (and centimetre) squares should be used at first.

Afterwards, the pupils should be supplied with square sheets 8 inches by 8 inches, and they should be made to construct the required inch squares by repeated foldings, learning incidentally a good deal about the fractions $\frac{1}{2}$, $\frac{1}{4}$, $\frac{1}{8}$.

Section II.

Arithmetic: Compound quantities including long and square measures.

The construction of models of solids, which can be built up with a child's set of bricks (cubes, square prisms and their halves) such as:—

A solid flight of 3 or 4 steps.
A solid letter L.
A solid cross.
A house with a 45° roof and so on.

These to be treated variously as in Section I.

The work here to be closely correlated with the Arithmetic so as to give (i) reality to ideas of area and volume, (ii) practice in measurement.

Dimensions should still be an exact number of inches or centimetres though halves, quarters, eighths and *tenths* should be gradually introduced and the boys should begin to use the graduated ruler (English and Metric).

Each model constructed should be made the basis of a set of exercises involving areas, volumes, weight and money.

Section III.

Arithmetic: Decimal and Vulgar Fractions.

The work here should be as in the last Section, but simple fractions and decimals (tenths) should be used freely.

Useful lessons can and should be given on the multiplication of decimal and vulgar fractions from the point of view of area.

They must be simple and well thought out.

The pupils should now begin to use the tape measure, measuring actual objects (*e.g.*, a room or a shed) to the nearest foot or yard, and constructing models to a simple scale.

They should also construct models of the more simple geometrical solids which can be developed by rolling on a plane. This method for rectangular figures (cube &c.) will already have been used.

They should now construct in this manner copies of tetrahedra, rectangular prisms with various section, cylinders and cones.

The practical determinations of π and the formulæ for the circumference and area of a circle.

Theoretical proof of area of a circle by fitting sectors alternately and "proceeding to the limit."

Arithmetical work, as before, of course. Both $\pi = 3\frac{1}{7}$ and $\pi = 3{\cdot}14$ should be used.

Section IV.

Arithmetic: Simple (and Compound) Proportion. (Unitary method leading to ratio method.)

Geometry: Introductory. The use of instruments.

Further construction to scale with arithmetical questions involving unitary method.

The theorems:—

"Areas (Volumes) of similar figures are in the ratio of the squares (cubes) of corresponding lines."

Proof by "induction." (Arithmetically.)

The construction, to scale, of models of real objects where some geometrical construction is necessary as, for instance—

A tray with sloping sides.

Lamp shade consisting of five or six quadrilaterals, &c.

Formulæ for the area of a triangle and the volume of a prism.

Arithmetical questions as before, but Generalised Arithmetic (the use of algebraic symbols) should now be introduced gradually.

Nowadays most boys work plane problems connected with the height of an object determined by a base line and two angular altitudes. The corresponding three-dimensioned problems, when the object does not stand on the base line, should be worked by three-dimensional models.

Section V.

Miscellaneous points to be considered:—

(i) The treatment of the more difficult mensuration formulæ, *e.g.*, volumes of pyramids and cones, area and volume of a sphere.

(ii) Orthogonal projections (plan and front and side elevations) in connection with solids.

(iii) The mathematical treatment of the sphere from the point of view of Geography—Latitude, Longitude, Time, Determination of radius of Earth, &c. &c.

(ii) COVENTRY, JOHN GULSON ELEMENTARY COUNCIL SCHOOL.

SCHEME OF MODELLING.

8 YEARS OLD.

Paper-Modelling.—Without adhesive.

Material.—Drawing Paper. Pressing Paper.

Instruments.—Ruler. Set Squares. Scissors. Pencil. Knitting Needle as Scorer.

I. *The use of scissors to obtain long clean cuts and to avoid ragged edges.*

(*a*) Strips cut along printed lines of old exercise books.

Straight lines and parallel lines taught.

The use of these strips in counting units; multiplication and addition; simple fractional parts; folded to make geometrical forms.

(*b*) Construction with ruler and set squares, and cutting out of simple geometrical figures, *e.g.*, (1) square; 2) triangle—demonstration of properties of these.

(*c*) Circles traced (use flat circular objects, *e.g.*, coins, or cylindrical objects, *e.g.*, jam jar) and cut out.

II. *Illustrative Models.*—Use of string knot for a fastening—knitting needle as piercer and scorer.

(*a*) *Flat Models.*—*e.g.*, Gridiron, Gate, Fencing, &c.:—strips of former exercises tied together to make simple construction.

(*b*) *Solid Models.*—Models from development without waste—simple cuts; overlapping sides for flanges: parts may be cut away to form legs, &c. *after* construction.

Easy objects used to illustrate home life and historical episode, *e.g.*, basket, chair, throne, dais, &c.

For Historical scenes, use in the first instance, Reading Book illustrations. Figures should be drawn somewhat larger, then coloured with crayon or brush, and cut out, leaving a foot for support. Subsequently these figures will be grouped together with furniture to illustrate the episode. A background of stiff card should be prepared either by the teacher or some senior scholars.

Suggested Episodes:—Alfred and the Cakes; Death of Caedmon; Canute on the seashore, &c.

Dramatisation.—These stories (among others) to be dramatised by class—then figures fixed in position or moved about as in a miniature theatre.

Recitation:—The Village Blacksmith.

9 Years Old.

Paper-Modelling.—Without adhesive by interlacing of strips or groove and tongue fastening. With adhesive by means of flanges; or the models may be strengthened with Kindergarten sticks where necessary.

I. *Strip-work continued.*—Geometrical development on plain paper.

(*a*) Narrow or wide plain strips developed and cut.—Border folding.

(*b*) Wide strips—folded—cutting transversely to a stop; narrow strips interlaced with these to form—

1. Book-markers of various designs, shields, &c.
2. Ambulance group, *e.g.*, Tent, Flagstaff, Waggon, &c., with Red-cross Badge. Nurse's armlet.

II. *Solid Models.*—Use of gum as adhesive.

Models similar in construction to those of preceding stage, but developed to give ¼-inch flange and waste cut away.

Consideration of the use of a flange—inside or outside a model.

Modelling should centre round some idea well within boy's daily experience, or connected with such subjects as History or Geography, and wherever possible, the whole class should co-operate to produce the desired group.

Suggested co-operative work:—

Home: Dining Room or Bed Room. *School*: Classroom showing desks and other furniture. *Street*: Baker's Shop or Butcher's Shop.

The boy at this stage requires a more satisfactory model than sufficed in the preceding stage, and so paper legs for his chairs and tables are no longer more than a make-believe. Hence such fragile construction should be reinforced by gumming Kindergarten sticks in support, and the use of tin lids or cardboard discs, where wheels are required, and axles of pins pushed into thin firewood strips should be resorted to.

Historical Models, e.g., Guy Fawkes discovered; Charles I. refused admission to Coventry; Bishops taken to Tower, &c.

Recitation, e.g., The Ropewalk; John Gilpin.

III. Geometry of easy plane figures, *e.g.*, Square. Rectangle. Triangle, &c. Their area—use of squared paper to determine this—the relation of the area of the one to the other.

10 Years Old.

Paper-Modelling.—Also in Thin Pulp Board where necessary; Materials and Instruments as before.

Use of Knife. Safety Ruler and Cutting Board when Pulp Board is used.

I. *Strip-Work continued.*—More advanced geometrical development and interlacing to produce such historical accessories, *e.g.*, Bishop's Mitre; King's Crown; Flags of British Isles—hence Union Jack.

II. *School Requisites.*—(*a*) Repairing of school books (where necessary); Covering Readers; Construction of simple Note Book.

(*b*) More personal nature.—Bag for Bank Book; Chocolate Box; Bag for Mothers Marketing.

III. *Construction of Geometrical Solids, e.g.*—Cube and other regular prisms.

The geometrical development of these solids—their properties, *e.g.*, surface, contents, &c.—verification of capacity by reference to graduated jar and sand—and of surface by reference to squared paper.

The use of these solids in co-operative work, *e.g.*

Square Prisms.—Models of hewn stone—built together to produce City Wall and Gate; St. Mary's Hall frontage; Monument—Martyr's Memorial, &c.

Hexagonal Prisms.—Fingal's Cave; Giant's Causeway, &c.

The use of a template—Candle or Lamp shade; Air Balloon (*vide* Practical Science).

IV. *Suggested Historical Episodes*—for co-operative modelling; Landing of Julius Cæsar; Boadicea; British War Chariot, &c.

V. *Practical Mathematics.*—Construction of Set Squares; Protractor; Cardboard strips pivoted to teach equality of adjacent and opposite angles, &c., and paper mounting to show properties of a triangle, parallelograms, &c.

VI. *Practical Science.*—Various simple experiments can be devised to illustrate, *e.g.*, the pressure of the atmosphere. Ventilation can be demonstrated by objects made out of cardboard, *e.g.*, Tobin, Sheringham systems, hopper ventilation. Bellows, balloons, &c. may also be made.

11 Years Old.

Paper-Modelling.—Also in Thin or Medium Pulp Board where necessary. Materials and Instruments as before.

The use of Home-made paste for Paper Covering and Mounting.

I. *Strip-Work continued.*—More advanced geometrical development and interlacing to produce such historical accessories, *e.g.*, Ceiling of Star Chamber; House Door during the Great Plague.

II. *Paper-Modelling.*—Historical Examples:—Cuffs and Collars—with tongue fastening—Cavalier and Puritan.

Geographical Examples—The use of a template—Moorish stool; Court of Alhambra.

Personal requisites, such as:—Pocket Comb Case; Needle book for mother.

III. *Card Binding and Covering:*—Thistle; Shamrock; European Flags; Union Jack.

IV. *Co-operative Construction:*—

Ancient Greece—The Parthenon; The Stadium.

Ancient Rome—Her Military Prowess—The Standard, Trireme, Circus.

V. *Practical Mathematics*:—
Flat Models.—Parallelograms; Triangles, revised; Product of $(a + b)^2$.

VI. *Practical Science*:—

Card construction—assisted where necessary by wire and wood strips.

1. Cards of various geometrical forms to show centre of gravity.

2. Levers—card strips to show three orders, with pill boxes and cotton to demonstrate principle of Moments; The Balance; The Roman Steelyard; bound card strips (very strong) and wire to make simple machines, *e.g.*, *Crank*—Bell pull; Reversing Motion; Downward force to produce Rotation.

3. The Wheel—Wheels and Pulleys; Windlass; Capstan; Cone driving.

12 Years Old.

Paper-Modelling.—Also in Thin or Medium Pulp Board where necessary. Materials and Instruments, as before.

I. *Strip-Work.*—Still more advanced development and interlacing to produce such a geographical example as a Kaffir shield.

II. *Personal Requisites.*—Correspondence, Travel, and School.

III. *Card Modelling.*—The Cylinder. Pipes as for gas, water, sewage leading to ideas of Tunnelling and Bridging.

IV. *Co-operative Modelling.*—To illustrate Geography.—Esquimaux Kayak; Canadian Birch Bark Canoe, &c.; Falls and Canon of Zambesi and Niagara; Canada; Grain Conveyance, Elevator and Transport.

V. *Practical Mathematics*—

(*a*) *Flat Models.*—Theorem of Pythagoras; Circle—its circumference, area; Parallel Ruler—Pantograph—Extension Tongs; Products of $(a + b)^2$, $(a - b)^2$; Factors of $(a^2 - b^2)$.

(*b*) *Solids.*—The Cube and Square Prism; Diagonal of Face and Diagonal of Solid; Relative Pyramids—their perpendiculars; The Cylinder.

VI. *Practical Science.*—Central idea—*the Elementary Truths of Heat, Light and Sound.*

(*c*) *Constructional Problems*—

1. Heat—conduction along rods; spiral wire extinguishes flame; Gauge and principle of Davy Lamp; boiling water in a paper bag; Expansion of Liquids and Solids.
2. Light—Reflection, *e.g.*, Kaleidoscope; Pin-hole camera; Refraction of Light.
3. Sound—Megaphone.

13 Years Old.

Paper- and Cardboard-Modelling.—As before.

I. *Personal Requisites.*

Whole set of School Exercise and Note Books—various methods of sewing, binding and covering.
Cylindrical Box with fitted lid for School Tools (Pen, Pencil, &c.).

II. *Co-operative Modelling.*—Suggested subjects illustrating History.

(*a*) *French Revolution.*—Guillotine; Tumbril; Bastille, &c.

(*b*) *Social.*—Pillory; Stocks; Polling Booth; Council Chamber. Means of Conveyance, *e.g.*, Litter; Stage coach; Jaunting car; Palanquin; Motor Car, &c.

III. *Practical Science and Measurement as required in Mathematics.*

(*a*) *Flat Models.*—*e.g.*, Circle—Circumference; Experimental value of π.
Area—Verification of Formula (1) by sectors (2) by weighing.
Cylinder and Cone—surface; verification of Formula.

(*b*) *Solids.*—*e.g.*, Cylinder, Cone and Sphere—Volume—water displacement—sand and graduated jar—calculation *cf.* containing square prism—Surface area of Sphere.

(*c*) *Instruments.*—*e.g.*, Vernier; Callipers; Opisometer, &c.

Plastic Modelling.

(*a*) *Aims.*—To cultivate natural instincts of pressing and rolling; *e.g.*, when a plastic body is found in the fingers, it is a natural response to press between fingers, or roll between palms.

This tendency to be directed to the production of objects of interest rather than a set of formal exercises.

(*b*) To cultivate the play instinct and give scope for objective (*cf.* verbal) expression.

The class subjects which most readily lend themselves to the provision of such topics are History, Geography, and Nature Study.

Wherever possible the plastic work should have some connection with, and, if possible, be employed as a supplement to the Paper Modelling, *e.g.*, in the Village Blacksmith group, the horse-shoes, anvil hammer, tongs and other implements, should be wholly fashioned in plastic, but in the case of the cart-wheel, while the hub and felloes are of plastic, the spokes are provided by match sticks, and the tyre by a strip of paper.

8 Years Old.

Material.—Clay.

Tools.—None, but fingers. Any characteristic markings that are considered necessary should be made by scratching with the finger nail.

Methods.—

(*a*) *Breaking-off with a twisting motion, and rolling with a circular motion.*

Hence—Marbles, Cricket Ball, Football, Orange, Lemon, &c.; or the material may be flattened to form Biscuit, Button, Medal, &c.; or flattened and pinched up to make Helmets and Hats of different periods.

(*b*) *Rolling with a reciprocal motion.*

First between closed fingers of both hands, and then between fingers and modelling board—Cylinder and thread.

Cylinder.—Candle, Night Light, Round Ruler, &c.
Set of Nine Pins, Dumb Bell, &c.

Stick or Thread.—Set of Wickets; Worm; Snake; coiled to make Bee Hive or Catherine Wheel.

Co-operative Modelling:—

1. *Guy Fawkes Day.*—Fireworks.
2. *Christmas.*—Pudding, Mince Pie, Mistletoe, &c.
3. *Summer.*—What I found on the sea shore, &c.

9 Years Old.

Plastic Modelling.—*Material and Tools* as before.

Formal Modelling as before.

Side slightly flattened.—Roman Capitals and Numerals.
e.g., Building-up Stonehenge, Cromlech, &c.
Banana, Cucumber, Marrow.

Co-operative Modelling.
Continuation of the above, on both individual and co-operative side.

10 Years Old.

Plastic Modelling.—Material—clay.
Tools—Modelling Board—Tools as before.

Modelling in the Round.

(*a*) Natural objects will now form the bulk of the subjects for study. These will be modelled in the hand first to get proportion and general characteristics: then placed on board and finished with as great a degree of accuracy as possible.

The same natural forms will be modelled as in previous stages, *e.g.*, Simple leaves, Fruits, Vegetables, Shells.

(*b*) Common objects will provide a variation from above, especially in winter. These should be treated as broadly as possible, every effort being made to see general proportions as quickly and with as little manipulation as possible, *e.g.*, Door-handle, Oil-can, Spanner, Hammer-head, &c.

Building Forms.—These should be produced on a previously pencil-sketched plan, and built piece by piece until the desired result is obtained, *e.g.*, Esquimaux Hut. Red Indian Hut. Kaffir Kraal.

11 Years Old.

Plastic Modelling.—Material—clay.
Tools—Board, Ruler, Home-made Tool.

Modelling on a Slab.—The use of a slab.
Construction—methods of. Sketching on and building forms on a slab.

(*a*) Flat objects, *e.g.*, Shields, Medals, &c.
(*b*) Common objects introducing strap forms, *e.g.*, Dog Collar, Neck-tie, &c.

Building Forms on a Slab.—As before.
Very simple leaves and common objects.

Modelling in the Round.—Occasional exercise in suitable objects previously studied, with the expressed purpose of cultivating rapid modelling of mass and chief characteristics.

These studies, if satisfactory, may be laid simply upon a prepared slab, and attention then given to detail.

12 Years Old.

Plastic Modelling.—Material—clay.
Tools—as before.

At this stage, it may be assumed that the boy can construct a slab with facility and a fair degree of accuracy, and so the slab, as a means of education, is exhausted, since he will begin to do the work mechanically, and with a mind not so alert. The boys should be encouraged to make their own modelling boards, provided with a rim, so that the slab may be constructed quite by mechanical means.

Modelling on Slab.—Natural Forms and Common Objects as before, but with greater attention to characteristic features and general form, *e.g.*, Boy's Cap, Tie, Collar, Boot; Fruits and Leaves.

Building upon the Slab.—Any suitable constructive exercise, *e.g.*, Building in the solid, Books, Chained Bible, Roman Lamp. Building in relief, Parthenon Frieze from photo. Horses or other animals, if sufficiently skilful.

Modelling in the Round.—Such Natural Forms as shells will give good practice in judgment of mass and proportion, and since the slab is now constructed mechanically, the greater part of the time can be given to accuracy of form.

Pottery.—Simple pottery built up on the coiled method may be introduced now and again with advantage.

13 YEARS OLD.

Plastic Modelling.—Material—clay.
Tools—as before.

The course will follow the general lines laid down for previous classes, and the subject set according to the ability of the boy (*see* Course for 12 years old).

Boys who are sufficiently advanced should be allowed to store their unfinished work, and given an opportunity to complete it on a subsequent occasion.

Natural Forms.—More difficult leaves and sprays.
Simple Tile design.

Copying Casts.—If not too advanced these may be offered towards the end of the year.

(iii.) LEICESTER, ST. PETER'S ELEMENTARY SCHOOL, UPPER CONDUIT STREET.

SYLLABUS OF HANDWORK.

General Notes.

Plasticine-Modelling. Standard I.
Cane-Weaving. Standard II.
Paper- and Cardboard-Modelling. Standards III., IV.
Wood-work. Standards V., VI., VII.

It should be noted that any of these materials may be given to any class, especially for the purpose of illustration, *e.g.*, Plasticine can, with advantage, be used throughout the School.

The aims of the teachers should be :—

(1) To develop the intelligence and reasoning faculties of the child and to lead him to exercise his observation and judgment by allowing free experiment and discussion.

(2) To make the Handwork useful in illustrating the various subjects in the school curriculum.

Use of Tools.

The children should be allowed to experiment freely with the tools, that unreasonable methods may be eliminated. Discussion should follow, not precede the experiment, and a correct method should be found and fixed upon.

Standard I.

Modelling in Plasticine.

Apparatus.—Plasticine, Millboards, Modelling Tools.
Method :—

I. Let the children have free use of the Plasticine, and make anything that they choose, that they may discover the properties of the material. Teacher should watch for unreasonable methods or failure to adapt means to end, &c. Discussion and criticism should follow, that errors may be corrected.

The following have been made :—
Baskets, Ladders, Barrow, Cricket Bat and Stumps, Bird's Nest.

II. Modelling from objects supplied to children :—
Simple Fruits, Vegetables, &c.

III. Expression Lessons:—
The reproduction of Stories, Recitations, Lessons, Incidents, &c.

IV. Illustrative work.
Plasticine lends itself admirably for illustration of lessons in:
(1) *History.*
(*a*) Scenes and Events, *e.g.*, King Arthur, &c.
(*b*) Weapons, Utensils, *e.g.*, Spears, Swords, Helmets, Pottery.
(2) *Geography.*
River Bed, Mountains, Islands, &c.
(3) *Science.*

Homes of Animals	-	Rabbit Hutch, Bird's Nest, Dog Kennel, &c.
Homes of Men	- -	Cave, Wigwam, Tent.
Flowers	- - -	Daffodil, Tulip, Crocus.

Drawing should be combined with the Modelling.

Standard II.

Cane-Weaving.

Apparatus.—Canes Nos. 0 and 3, Scissors, Rulers and Pencils.

Method:—

I. The children to be shown a centre previously made of very thick cane. This is slowly unwound so that the children may see how it is done. A similar centre is then to be made. Having taught this, let the work at once be connected with Drawing.

II. *Models shown by Teacher.*—Mats, Baskets of different shapes and sizes. Teacher shows model with drawing on Blackboard, stating the size, so that they may be enabled to know shape and size of object. Borders are here introduced, being taught by the method of No. I. above, viz.: by undoing. The children will soon be able to make similar objects, choosing their own dimensions.

III. *Models of children's own choice.*—A sketch of the object chosen, stating measurements, should be made. These should be submitted for approval.

The following have been made:—
Hats, Cradles, Tables, Chairs, Stools, Umbrella Carriers, Rattles, &c.

Note.—The various designs in borders, and the different weaves should be taught in the same way, but it is more important that the children should choose and design objects with simple weaves and borders, than that they should know the more difficult ones.

Standards III. and IV.

Paper- and Cardboard-Modelling.

Apparatus.—Paper, Thin Cardboard, Ruler, Pencil, Set Squares, Compass, Punch, and Krux Gum.

Method:—

I. Geometrical Forms, such as Square, Oblong, Circle, and Triangle, to be taught experimentally.
Paper to be used at this stage.
(*a*) Show an object previously made, *e.g.*, Mat, Label, Postcard, &c. This should be examined and discussed, the children saying all they can about shape, size, number and kinds of lines and corners.
(*b*) The object to be made by what method the children choose.
(*c*) Methods of working, &c. to be discussed and criticised.
Cardboard is here introduced, and the best way of cutting and bending it is discovered by experiment.

II. Object with working drawing is shown.
A similar object is then drawn, and made by the children according to their own measurements.

Teacher should here observe—

(*a*) Children actually make the object according to shape and size decided upon.

(*b*) That the Cardboard is economically used.

III. Children to make whatever they please. A sketch of the proposed object to be made and submitted for approval; then the working drawing of each part to show developments.

This is transferred to Cardboard.

The following have been made:—Stools, Chairs, Tables, Cupboards, Boxes, Tidies, Dog Kennel, Book Shelves, Swings.

IV. Correlation with other subjects. Cardboard lends itself admirably for this purpose, and has proved especially valuable in the teaching of Arithmetic, &c.

Standards V., VI., VII.

Light Wood-work.

Apparatus.—Wood. American White, Yellow Pine $\frac{3}{16}$ inch planed both sides, Lime $\frac{1}{2}$ inch, American White, Yellow Pine 1 inch unplaned, Knives, Cutting Boards, Steel Rules, Try Squares, Hammers, Back Saws 5 inch, Gimp Pins No. 19, Jennings Bit $\frac{3}{16}$ inch, Hatchet, Panel Saw, Oilstones, Glass Paper.

Use and Application of Tools.

The method suggested in "General Notes" is to be pursued with the exception of the use of the knife, as wrong usage of this tool might result in injury to the child. In this case discussion should precede experiment, and correct method insisted upon, viz.:—

(1) Knife must be held under left hand.

(2) Child must cut down upon the block.

Method.

I. Flat Models. These to be based upon the Square, Oblong, Triangle, &c. Object is shown, children cut a similar one, using their own judgment as to size, &c.

The Teacher to observe—

(*a*) That children actually make the object the shape and size decided upon.

(*b*) That they make the most and best use of the wood at their disposal. Flower Stands, Labels, Ruler, Wool Winder, &c., are specimens of such Models.

II. Models using more than one piece of wood, and based on some definite geometrical form. Model to be suggested by the teacher, *e.g.*, Box. Boys to choose design, size and use.

Sketch of proposed Box to be drawn and submitted for approval. Working drawings of each part in its correct position to be made. The amount of wood required, to be calculated and stated.

III. Models of Boy's own choice.

Method of working as above.

The following have been made:—Ladder, Letter Rack, Stationery Case, Inkstand, Cannon, Fence, Hut, Swing, Teetotum, &c.

IV. Models for Illustration.

History, Geography, Literature, &c. can be made more vivid and interesting by judicious use of hand work.

V. *Collective Work.*

In this each boy takes some definite part, and the work is done to scale, *e.g.*, their own classroom.

(iv) SUGGESTED SYLLABUS OF LIGHT WOOD-WORK FOR SECONDARY SCHOOLS.

(Supplied by Mr. A. OGDEN, Manchester Grammar School.)

It is assumed that this form of Handwork is to be done in the ordinary class-room and taken by the class teacher. It is also assumed that the class consists of not more than 20 children to 1 teacher and that the children are reasonably acquainted with the use of the rule.

Equipment.

Each child to be provided with a hard wood board, which when placed upon the desk, will form a horizontal table top. To this board there must be secured a *mitre-cut* and a simple *vice*.

Tools.

Small brass-backed saw - -
Small well-balanced hammer - } For each child.
Sloyd knife, Non-slip rule -

No.	Name.	Size.
6	Iron clinching blocks - - - - - -	3″ × 3″ × 1″
4	Bevis cutting pliers - - - - - - -	—
10	Flat files (medium cut) - - - - - -	8″
4	Half-round files (Do.) - - - - - -	8″
2	Dovetail saws - - - - - - - -	10″
1 doz.	Spring bits - - - - - - - -	Fine.

The above is based upon an estimate of 20 places.

Material.

1 lb. each of ½″, ¾″, 1″ fine panel pins.

Canary wood—American White wood in strips 2 ft. × ½″ × ¼″ and half the quantity of 2 ft. × ½″ × ½″. The planed imported boards ½″ thick are most suitable for this work. They should be cross cut to 2 ft. lengths and then with a fine circular saw the 2 ft. lengths should be cut into strips of the required size. The greatest accuracy is needed in this sawing, or the children will not build well and all efforts to get accuracy of measurement will be defeated.

Note on Material.

The sawing must be done by a local joiner, having a Power saw. The wood and its cutting is an expensive item, but it is true economy to buy the best wood and employ a good sawyer. An allowance of sixpence per place per term will cover cost of material and will allow for depreciation of tools.

Method.

The preparatory models for the first stage of the work may take the form of Squares, Triangles, Windmill, Railway signals, Finger post, Weather Vane, Turnstile, Giants' Stride, Gateway, Fencing, Chair, Table

A large number of models are within the scope of this stage, which is designed to give the learner practice in the use of tools.

In the second stage it is well to get the class to concentrate upon some pre-arranged scheme and to work for its orderly completion in concrete form.

Following a suggestion of the teacher, a Farm is fixed upon as the subject. The children name all the objects—known to them—that go to the formation of a farm building and its equipment.

Great use is made of the Blackboard and gradually the scheme is visualised. The models are apportioned by the teacher who by this time knows the capabilities of the individual, and each unit of the class begins

his work, by making a sketch of his part and submitting the same for criticism. He then receives his wood and finally makes his model to a scale of 1″ = 1 ft.

When the finished models are grouped to form the pre-arranged scheme, the children realise that the conception first formed has through their fingers become a concrete reality.

Examples of what may be done in co-operative work.

Camp-life.—This is associated with the earlier Paper-work, and suggests school camps. Scouts.

The Railway.—Signal Cabin, Sets of Signals, Gates at level crossings, Bridges, Barrows and Trucks, Station Platform, Crane.

The Gymnasium.—Giving Ladders, Parallel and Horizontal bars, Climbing rope and pole, the Rings, Trapeze, Swing, &c.

The Home.—Gives the greatest possible scope for models. The work may be distinctly associated with the lessons of the school.

History.—A Drawbridge, a Catapult, a Ballista may be made.

Geography.—Means of transport.

A series of models illustrating the evolution of the cart from the poles placed across the withers of horses to the present form of four-wheeled cart and the railway truck.

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4. RURAL SECONDARY SCHOOLS.

(i.) RURAL SECONDARY SCHOOL, KNARESBOROUGH, YORKSHIRE

SCHEMES OF PRACTICAL WORK IN SCIENCE (CHEMISTRY AND PHYSICS), NATURE STUDY, GARDENING, WOOD-WORK, POULTRY AND BEE-KEEPING.

Nature Study.

Preparatory Course.

Examination of seeds. Determination of suitable conditions for growth. Careful observation of growth and development of seedling.

Preparation of plants for winter—comparison with animal.

Excursion to note specially the appearance of the country at the time of the year, and particularly to note one special feature; for example, one tree to be visited during the whole year.

Planting of bulbs—examination of winter-buds—observation of their development.

Examination and comparison of typical roots, stems, and leaves, with simple experiments showing the work they perform. Simple study of flowers.

First Year.—90 minutes per week.

Examine Kidney or Broad Bean—skin, germ, store of food. Sow Bean. Note increase in size (measure volume). Weight. Watch growth for three weeks; note changes. Seed absorbs water, swells, gives off a gas, root appears and grows downwards. Shoot appears and grows upwards. Seed-coat bursts, food diminishes. Branches on root—seed-leaves, foliage-leaves.

Sow bean various ways up; root grows down, shoot up always.

Grow wheat, barley, or oats; mustard or radish (monocotyledon and dicotyledon).

Show how iodine behaves with starch; hence starch test. Test food store in seeds—seed-leaves thick and fleshy; test for starch. Compare with barley and oats. Food in seed-leaves or separate. Grow mustard-seed—wet and dry, with and without air, cold and warm, light and dark, scattered on surface, shallow and deep.

Sow beans half immersed in damp sand in positions before indicated. Water enters chiefly through small opening. Seed coat is porous. Construct summary.

Examine mustard seedling. Root below ground, grows down, white or brown; no leaves. Shoot above ground, grows up, green. Seed-leaves, foliage-leaves. Cut seed-leaves off mustard seedling, thus show their value.

Examine groundsel plant.

Root below ground, spreads below to keep plant firm—white and brown—does not bear leaves, flowers, &c. Roots slender.

Shoot above ground, spreads above to sunlight and air, green. Bears leaves, buds, flowers, fruits, seed. Stem stout, why?

Examine lilac or privet leaf.

Stalk (not stem). Place of attachment enlarged, why? Continues as main vein. Why has the leaf a stalk? Blade thin and flat; shape. Colour of upper and lower surface. Flesh of leaf. Veins main and side—apex or point; margin or edge.

Evergreens. Deciduous plants. Compare length of stalks of laurel and sycamore. Reasons.

Respiration. Dip cherry laurel leaf in hot water. Bubbles of air given off chiefly from under side. Presence of air in leaves, many small holes on under side of leaf, large amount of air in veins. Cut a laurel leaf transversely, dip in hot water, stream of air bubbles from main and minor veins. Dip a piece of very narrow tubing in water. Veins are tubes, air collects in veins.

Dip a laurel leaf, cut down centre of main vein, into hot water; side veins are connected with main veins.

Dip a piece of wood (stem or pencil) and root of any plant into hot water; note bubbles. Presence of air all over plant, presence of tubes; probably circulatory system.

Illustrate by connecting stem of arum lily to cycle pump, immerse stem in water and pump through.

Transpiration. Buttercup leaf under inverted beaker, water given off. Hawthorn leaf treated with cobalt chloride paper shows chiefly from under surface. Probably same holes as air.

Test nasturtium or French marigold leaves for starch.

Confirm suggestion why leaf is thin, has a stalk, &c. Construct summary.

Necessity for cleanliness, fresh air, sunlight for indoor plants. Effects of overcrowding plants; thinning out, &c.

Test for starch in potato, seed of wheat or bean, leaf stalk of cabbage, turnip; hence storage of food. For what purpose? How utilized by plants and animals.

Shape of leaves may be treated here if desired.

Examine lilac, simple; horse-chestnut, compound; grass, line-like; iris, sword-shaped; privet, oval; lilac, heart; ground-ivy, kidney; nasturtium, round.

Veins.—Grass, parallel (one seed-leaf). Turnip or lilac, two seed-leaves, a network. *Margin.*—Lilac, unbroken; oak, wavy; nettle, saw-like; sage, rounded.

Compare chestnut and sycamore; when indentation reaches margin—compound.

Stem.—Examine privet spray. Main stem, joints, interjoints, end bud, side buds, pores, leaf-angle (containing side-bud), leaf-scar (cabbage and pine-needle), shortened stem.

Stem shortened or elongated. Work of leaves in each case.

Buds.—Examine horse-chestnut bud, found in axil of leaf, bud-scales, leaves, flowers and woolly substance.

Grow a winter twig in a warm place. Rings caused by scales—contain leaves and flowers. Rings occur where growth commences each spring.

Examine cabbage, Brussels sprout, onion, tulip—contain same parts as stem but packed close together. Bud is an undeveloped branch. From same specimens, examine flower-buds, foliage-buds, winter buds (protected), summer buds. Dormant and active buds. Examine unpruned apple tree; tree pruned previous year.

Scarlet runner seedling, and one with end summer-bud nipped out. Some buds remain dormant. This prevents overcrowding of foliage, and is a safeguard against damage by birds, frost, &c.

Dormant buds develop when active ones are removed. Principles of pruning.

Arrangement of buds. Examine Beech twig—singly, alternate; plum, singly, spiral; horse-chestnut, in pairs, opposite and alternate. Summary.

Second Year. 90 minutes per week.

Flowers.—Examine buttercup (R. bulbosus). Flower stalk, sepals, petals stamens, seed-box--simple flower.

Examine stamen of nasturtium—anther, two boxes, yellow powder, pollen, Stalk, filament. Examine pistil of godetia—sticky stigma—stalk (style)—seed boxes. Value of the various parts. Examine dandelion. Made up of a number of florets. Bracts, flower-cushion. Ray florets, disc florets. Use of sepals to carry seeds. Composite flower. Construct summary.

Fruits.—Haw, cherry seed-pulp food for birds. Skin protection and attraction. Fruit of sycamore and ash—seed + three layers of covering.

Dry and succulent fruits. Simple and compound fruits. Examine blackberry, raspberry. A number of fruits similar to cherry. Aggregate fruit formed from a number of separate seed-boxes, borne on the same flower. Construct summary.

Dispersal of Seed.—Bramble, cherry, haw: spread by birds.
Avens, goose grass: spread by adhering to animals by hooks.
Groundsel, dandelion: seed light and carried by wind.
American Balsam, stock: explosive.
Poppy, pores in capsule.
Alder: wind and water.
Construct summary.

Root.—Grow Bean seedling in sawdust, cut through root about 1 inch below surface. Root fixes plant.

Place root of groundsel plant in water in test-tube. Note level of water daily—compare bright and dull days. Root takes in water.

Place root of groundsel in red ink solution and another in carmine suspended in water. Cut across stem just above water level. Roots take up dissolved but not suspended substances. Examine root of bean and mustard grown on moist flannel. Growing portion—root-hairs. Mark roots at regular intervals and determine growing portion. Take pea or bean seedlings with roots 1 inch long, fix between two corks in test-tube, the upper cork fitting test-tube with seed fastened to it, the root-tip just touching lower cork floating on water. Root presses downwards. Take plants with roots upwards, place in suitable situation—roots turn downwards.

Plant in dry sawdust, but close to flower-pot containing wet sawdust, Root attracted by water.

Grow bean or pea in sawdust on coarse muslin over stoneware jam-jar. When roots are 1 inch long replace by glass jar. Roots turn from light. Repeat these experiments, cutting off the root-tips in each case; the root-tip is the sensitive portion.

Examine root of carrot, turnip, grass, onion, taproot, fibrous root.

Show Fehling's Test for sugar.

Test for starch and sugar in turnip, potato, celery, onion, carrot, beet, cabbage leaf-stalk, perennial sunflower (root), root of any tree, weed, bean.

Food stored :—In seed only—annuals.
,, root, stem, leaves—biennials.
,, root and stem—perennials.

Construct summary.

Stem.—Examine potato, couch grass, strawberry, gooseberry, any herbaceous plant, runner bean, crocus, tulip, sedge, artichoke.

Aerial stems—stout and erect—climbing or creeping, too slender to support themselves in an upright position.

Underground stems—Bulb, corm, tuber, rhizome.

Construct summary.

Examine sloe and hawthorn—thorn a branch. Rose-thorn, outgrowth of rind. Nettle hairs. Value of each to plant.

Examine transverse sections of horse-chestnut or apple. Cork, bark, growing layer, heart-wood, annual rings, pith.

How growth takes place (relation to budding and grafting).

Climbing stems. Reasons for climbing.

Scarlet runner and hop—twining stem, sense of touch.

Ivy, adventitious roots.

Third Year. The Soil.

Dig hole 2 or 3 feet deep. Soil and subsoil. Examine sample of surface soil with lens. Compare subsoil. Estimate water in soil and subsoil by drying. Estimate organic matter in each by burning, till terra-cotta in colour. Estimate grit by decantation. Sediment—clay.

Allow liquid decanted to stand for two or three days. Pour off clear liquid. Dry and weigh—note appearance on drying. Result—soil-water, stones, grit and sand, clay and organic matter. Surface soil loose, easy to work, dark in colour, not so many stones, contains organic matter. Subsoil, solid, difficult to work, sticky, light colour, many stones, organic matter absent or in small quantity.

Soil dried, hard and crumbly ; when moistened, returns to original state Soil burnt : loss of water, loss of organic matter, will not return to original state when moistened. Why ?

Clay easily suspended in water—why ?

Is a large lump easily suspendable ? Is it heavier than water ? Show that clay shrinks in drying. Note cracks. Moisten : it swells again. Note slippery nature. Show clay holds water and is air-tight. Action of air upon clay, action of frost—autumn cultivation.

Sow seeds in moist clay and in moist soil.

Note effect of water on dried clay and on burnt clay. Show action of lime on clay. Lime water and clay water coagulate. Put clay in funnel, sprinkle with lime, cover with water ; it becomes porous. Similarly show action of salt on clay. Knead clay with rain-water and with lime-water—pasty nature removed (liming).

Sand. Compare with clay—physically. Show sand is heavier than clay by weighing equal volumes. Apparent heaviness due to water and sticky nature when worked.

Construct summary.

Effect of mixing sand and clay—clay loam, sandy loam.

Organic portion of the soil—how formed. Examine soil from a wood, estimate organic matter in leaf-mould, farmyard manure, garden soil, subsoil, clay. Compare throughout the process—residue.

Food in soils. Sow mustard seed in sand, surface soil, clay. Show that food is used by growing plant by sowing mustard seed on soil previously cropped. Whence comes plant food ? Sow mustard seed in surface soil

and surface soil + leaf mould. Estimate soluble matter in surface soil, subsoil, sand and clay.

Construct summary.

Life in soil. Place damp soil in bottle; cork and watch growth. Action of earthworms. Put earthworm in pot of soil. Examine soil after some months. Compare with similar pot without worms.

Presence of bacteria. Suspend baked soil and ordinary soil in separate flasks of boiled milk. Examine after a few days.

Oxidation in soils. Suspend soil in flask, containing a little lime water —evidence of CO_2.

Use dry soil similarly: no effect: moisten, note action.

Soil and water. How soils remain moist though porous. Pour measured water over dry soil in funnel, measure water that runs through. Retentive power.

Repeat with various classes of soils and compare results. Show by means of broken glass of various sizes that the retentive power is dependent upon the size of the particles, or area of the surface.

Capillary attraction. Show principle by tubes of various bores. Tie a piece of muslin over the end of a tube filled with dry soil. Place in water and note the height to which water will rise. Compare heights with various classes of soils.

Expose weighed dry soil—weigh again.

Renewal of air in soil. Pour water over soil in tube: water displaced air: fresh air follows the water.

Retention of ammonia. Pour very dilute ammonia through dry soil in tube—test liquid which passed through for ammonia. Grow plants in lamp glasses watered only from the bottom, using various classes of soil.

Effect of water on plants. Grow mustard seed in pots, and (1) water sparingly, (2) keep uniformly moist, (3) keep very wet with drainage hole fastened up. Make summary.

Excursions to note plants on various classes of land.

Cultivation. Show effect of hoeing on temperature and water in soil also effect of mulching with straw manure. Effect of stones.

Compare amount of water in cropped and uncropped soil. Effect of colour on temperature.

Formation of soils. Action of rain and frost.

Root sap. Grow seedling on polished marble or stone.

Burrowing animals, earthworms. Action of acids.

Rivers—examine deposit at bottom of cliff: order of deposit. Examine winding river, present and past course. Local and transported soils. Possible differences. (To be taken on excursions before class discussion. Much of this matter will have been previously dealt with in the Geography lessons and excursions.)

How plants feed—principle of osmosis (recapitulation). Capillary attraction in plants. Root pressure (cabbage plant).

Effect of transpiration (suction). Deposit of substances in solution.

Utilisation of stored food. Starch insoluble in cold water.

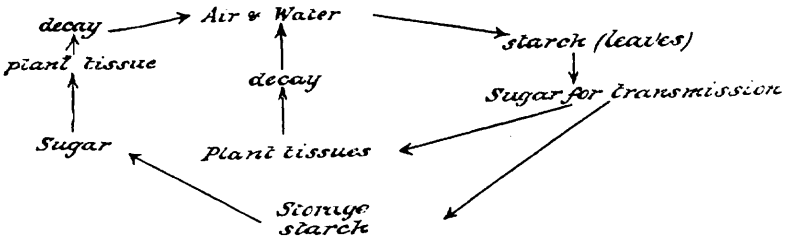
Test for starch in wheat grain. Grow wheat till shoot is about 2 ins. long. Test for starch and sugar. Show action of saliva on starch; sugar ferments, enzymes, ptyalin.

Extract solution from nasturtium leaf after bright day, act on starch—starch converted into sugar. Presence of ferment for conversion of starch to sugar where (*a*) starch is made, (*b*) starch is stored. Action like ptyalin. Heat a piece of starch—water and carbon dioxide.

Collect gas from decaying plants. Test for carbon dioxide. Decay of plants—cycle of starch. (*See* diagram on page 109.)

Pollination. Examine bean flower. Remove anthers before ripe and (1) leave flower for insects to visit, (2) cover with muslin bag. Remove stigma. Cover complete flower with muslin. Pollen is necessary—stigma is necessary. May be self-fertilized.

Cross fertilization and self-fertilization. Remove anthers from bean flower, pollinate (i) from flower on same plant, and (ii) from flower on another bean plant, (iii) from a plant of distinct genus. Hence show necessity of pollen from same kind of plant. Watch a bee visiting flowers —carrying pollen.



Put a few grains of pollen of Broad Bean or pea in 10 per cent. solution of sugar—in ½ or 1 hour a tube grows out.

Examine flower of wheat or Timophy. Note absence of colour, pendulous stamens, long filaments, hairy stigma—wind fertilized. Value of honey to plant.

White flowers, night pollination by moths; coloured, day-time by bees; colourless or inconspicuous, by wind. Construct summary.

Excursions to compare characteristics of cruciferæ, Rosaceæ, Ranunculaceæ, Gramineæ, Liliaceæ, Leguminosæ; cultivated plants and weeds of each order.

Non-flowering plants. Examine *Aspidium* or other fern. Habitat: woods, damp places, no flowers. Spores; grow spores in greenhouse; spore—thallus—fern, no aerial main-stem.

Funaria.—Habitat, structure, no flowers; capsule and spores.

Marchantia.—Leaf-like structure of thallus, no definite stem, root or leaves. Adventitious rhizoids—spores.

Moulds. Examine mould on cheese. Absence of green colour, thread-like thallus—spore cases.

Experiments with moulds. Use bread or nutrient jelly. Expose piece of dry bread and moist. Sterilized—disinfected. Dust with spores and grow in dark and light, in close and free air.

Examine lichens (grey); absence of green colour, thread-like thallus—spore cases.

All this work should be in close association with excursions.

Bacteria.—Examine fresh milk under microscope, allow to turn sour and again examine. Sterilize and keep cool. To another portion add a drop of sour milk and some disinfectant or salt. Conditions favourable and unfavourable for growth. Cleanliness, use of disinfectants, cooking, ventilation.

Decay, decomposition, fermentation, spreading of diseases.

Study of animals throughout the year by excursions to good farms.

Fourth Year. (*Suggestions.*)

Common grasses—where found. Useful and useless.
Structure of plants—use of the microscope.
Nitrification and fixation of nitrogen.
Available plant-food—fertility.
Manures and fertilizers.
Essential elements in plant-food. Natural sources of nitrogen.

Phosphoric acid and potash.
Selective power of roots. Rotations.
Water and sand cultures.
Observations of Farm crops.
Parasitic and saprophytic plants—total and partial.
Geographical distribution of plants.
Foodstuffs—various classes—work of each.
Milk, cheese, butter.
Principles of separating—butter-making, cheese-making, milk-testing.

EXPERIMENTAL SCIENCE.

(Outline scheme only.)

First Year.

90 minutes per week.
Elementary work in Physics and Chemistry.
Three states of matter—chief properties. Examination of common substances, selected for practical interest in connection with the Nature Study, Geographical and Domestic work.
Measurement of volumes, finding densities.
Study of solution, evaporation, crystallization, distillation, boiling, condensation.
Study of air—oxygen, carbon dioxide.
Rusting and other cases of oxidation.
Properties of common oxides.

Second Year.

Properties of the common acids—and alkalis.
Neutralization to form salts.
Action of metals on acids. Preparation and properties of hydrogen.
Composition of water. Properties of water, chemical and physical. Natural waters.
Action of sodium potassium and iron on water.
Everyday methods of protecting metals from the action of water. Domestic utensils.
Examination of nitrogen compounds.

Third Year.

Boys.—Elementary Applied Mechanics—machines.
Chemistry of plant-life. Testing various plant structures and food substances for essential elements (*e.g.*, reserve organs, leaves, bones, minerals, &c.).
Heat: its measurement—its effects, expansion, &c. Conduction, convection, radiation. Practical application of results (*e.g.*, non-conducting structures, heating apparatus).
Latent heat.

Girls.—Chemistry of everyday life—plant elements. Food substances, starch, sugar, glucose. Action of yeast on glucose.
Alcohol, preparation and properties. Methylated spirit.
Boiling point of various substances.
Acetic fermentation—vinegar.
Tartaric acid, baking powder, effervescing drinks.
Fats and oils. Soaps—how made. Glycerine.
Sugar, cane sugar, treacle, caramel, lactose, honey.
Starch—obtain and examine various starches.
Flour—gluten and starch, separation and estimation of proportion.

Fourth Year.

Extension of the work of the third year, with more detailed study of the subjects included and the addition of the following:—

Boys.—Quantitative estimations—gravimetric and volumetric; complete analysis (qualitative) of plants, soils and manures ("artificial").

More difficult experiments in Heat.

If time permits the rudiments of Electricity may be taken, with special reference to its practical applications.

Girls.—Further work in the Chemistry of everyday life and additional experiments in heat.

PREPARATORY COURSE OF HANDWORK.

(1 hour 25 minutes per week.)

One Year—before commencement of the *First-Year Course.*

Section I.—Line and Rectangle.

1. The line and its measurement. Metric System. Drawing of lines.
2. The angle and its measurement.
3. Lines enclosing rectangle—square and oblong—area.
4. Scale Drawing.
5. Making square envelope—handkerchief case.
6. Making of any article suggested by the pupils, form based on the square.
7. The oblong, further exercises in calculation of area—oblong envelope.
8. The square or oblong tray.
9. The square or oblong tray with sloping sides.

Section II.—Cube and rectangular prism.

1. The square box—sides = base.
2. The cube—meaning and calculation of volume.
3. Further exercises in the calculation of volume.
4. Fancy boxes. Form based on cube.
5. Oblong box with lid.
6. Rectangular prism.
7. Article—*e.g.*, hair-pin box, hat-pin box, glove and handkerchief box—form based on rectangular prism.
8. Pupils' original ideas, based on above forms, for the making of articles, to be worked out. All to be made in paper of various thicknesses and colours. Some scope to be allowed in decorative work—free brush drawing, stencilling, embroidery.

Section III.—The triangle.

1. The 3-sided figure—various forms.
2. Triangular box with lid.
3. Tetrahedron.
4. Fancy box on triangular form.
5. Making article suggested by pupil.
6. Exercises in binding.
7. Article based on triangle, involving binding.
8. Calculation of area of triangle: formula discovered by cutting and superposition.

Section IV.—The circle.

1. The circle. Relation of its radius to circumference.

2–8. Making of articles based on the circular form. Teapot stand or mat. Collar box. Hat-pin stand. Cylinder lamp or candle shade.

Section V.—The hexagon and octagon.

1–6. Making of articles based on these forms. Hexagonal mat or box tray with slanting sides—cake basket, &c.

Section VI.

Making of set of Geometrical models, and of articles based on forms of sections I. to V. in paper or cardboard.

Scope to be given for originality in design. Making up and decoration.

WOOD-WORK.

(Time per week, 1 hour 35 minutes.)

First Year.

Sawing: use of Hand, Tenon, and Rip Saws.

Planing: Jack Plane. Use of Try-Square and Marking Gauge.

The making of simple joints. Nailing: use of Bradawl and Hammer. Screwing: Gimlet and Screwdriver.

Paring: use of chisel. Boring with Brace and Bit.

Plan and Sectional Drawing.

Demonstrations on use of various tools.

Lessons on different kinds of wood and their value for special purposes.

Construction of the following models:—

- Tree or Plant Labels.
- Various Pales for Fencing.
- Dahlia Stakes.
- Bench Hooks.
- Pea Guards.
- Garden Plot Markers.
- Various kinds of boxes:—Seed Boxes, Potato Set Boxes, Nail Boxes, Try-Square, T-Square, &c.

Second Year.

- Tongue and Groove joints.
- Planing with Try-Plane and Smoothing Plane.
- Mortise and Tenon joints.
- Proper use of Mortise Gauge and Chisels

Use of Bow Saw and Pad Saw.

Mitre Joint. Double Lip Joint.

Lessons on value of timber.

The constructional work includes:—

Boarding, erection of Hen Coops, Cold Brooder, Shelving Poultry Houses, Mitre Boxes, Handles for Hammers, Shafts for Rakes, &c. Doors—with Halving Joints, Fencing.

Third and Fourth Year.

Plan and sectional drawing of more difficult pieces of work, various scales.

Calculation of the valu of the timber used, and estimation of the value of labour, in constructional work.

The care of tools—grinding and sharpening.

The constructional work includes:—

Dovetail joints, used in making Boxes for various purposes, corn bins.

Garden Frames (full size), with Mortise and tenon joints, Rebating, &c.

Field or Garden Gates.

Framing for Museum Case, Cupboard Doors.

Small Glass-house. Small Windows.

Garden Wheelbarrow. Beehives (modern box-type).

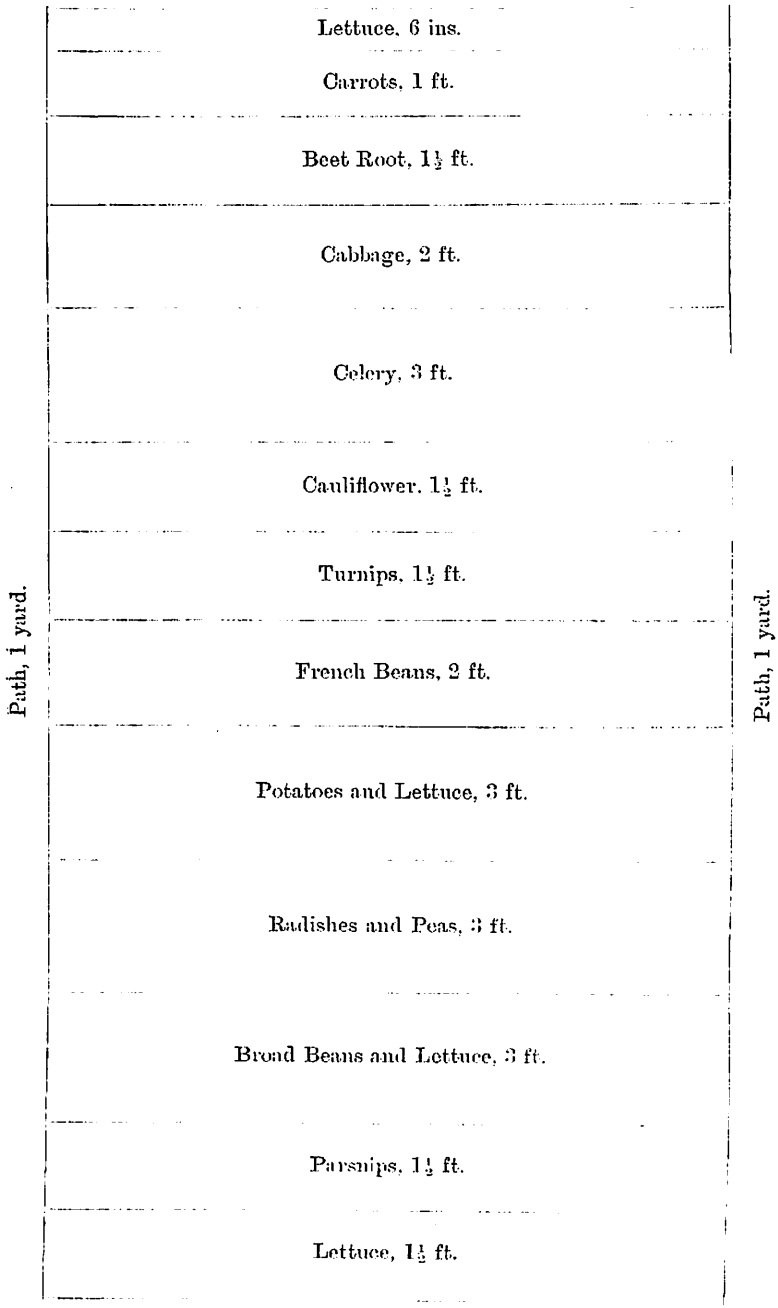
In addition to the above, small pieces of apparatus required in the Science laboratory are occasionally made, such as Balance Bridges for specific gravity work, pipette holders, &c.

GARDENING.

(*Boys.*)

The plots are arranged in the dual plot system—the area of each plot being 8 yards × 3 yards. All plants grown on the plots are raised from seed by the boys.

Plan of Plot.



The arrangement is varied from year to year for securing (1) economy of cropping, and (2) rotation.

The boys are encouraged to fill up in any way that occurs to them any blank spaces that may for any reason occur on their plots.

Forms IV. and V. pruned all the fruit trees in the garden. Cuttings were taken of Red and White Currants, Gooseberry, Privet, Laurel, Violas, Pansies, Geraniums.

Other work consisted of making potting soil and composts, storage of crops—potatoes and turnips in pies or clamps. Insect pests were dealt with in the garden. When any particular pest was found, it was discussed, and methods of prevention tried.

The boys of Forms IV. and V. took charge of greenhouse and frame as occasion required.

A model cottage garden was arranged and a common plot worked, from which specimens for examination were procured as seemed necessary. A series of experimental plots were run; these varied from year to year.

Examples:—

Potatoes were sown in small plots, the idea of the experiment being to determine the best sort of sett and the best way to treat it before being planted:—

Plot.	Sort of Sett used.	Yields in lbs.		
		Using.	Setts.	Chats
1	Medium sized setts—not sprouted	10½	4¾	3¾
2	Large setts—sprouted	19¾	6	1
3	Cut setts—sprouted	16¾	4½	1
4	Medium setts—sprouted	31	3½	1⅜
5	Small setts—sprouted	21	10	1¼
6	Medium setts—sprouted, all eyes removed but one after sprouting.	14¾	1½	1½

Experiment to show the value of deep cultivation. Each plot was 2 yards square—Crop. French Beans:—

Plot left solid - - Yield 7½ lbs.
„ dug one spade depth - - „ 11 „
„ „ two „ „ - - - „ 13 „

The following varieties of vegetables have been found good:—

Crop.	Variety.	Sown.	Depth, approx.	Trans-planted.	Distance apart.
Lettuce	Paris White Co.'s	Mar.	½ in.	Apr.	1 ft.
Carrots	Early Nantes Scarlet Intermediate	Apr.	1 in.	—	4 in. to 6 in.
Beet	Turnip-rooted Blood-red	May	1 in.	—	4 in. to 6 in.
Early Cabbage	Ellam's Early	Mar.	½ in.	Apr. May	1 ft. 1 ft. 6 in.
Celery	Superb Pink Major Clarke	Mar.	½ in.	June	1 ft.
Cauliflower	Early London White Snow Queen	Mar.	½ in.	Apr. May	1ft.6in.

Crop.	Variety.	Sown.	Depth, approx.	Transplanted.	Distance apart.
Turnip	Snow White Garden Swede	May	½ in. to 1 in.	—	6 in.
Potato	Sharpe's Express	Apr.	6 in.	—	1 ft. 6 in.
Peas	Gradus Thos. Laxton	Apr.	2 in.	—	2 in.
Broad Bean	Exhibition Longpod Windsor	Mar.	3 in.	—	4 in.
Parsnip	Hollow crowned Student	Mar.	1 in.	—	6 in.
Savoy	Drumhead	May	1 in.	—	2 ft.
Brussels sprouts.	Aigbruth Wraxton	May	1 in.	—	2 ft.
Coleworts	Sutton's Hardy	May	1 in.	—	2 ft.

The early lettuces, early cabbage, celery, and cauliflowers, were started in the greenhouse.

The crops are so arranged that one half of the plot each year (alternate) carries a double crop, the remaining half being bare in order to allow the boys to practise the various forms of winter or deep autumn cultivation (double digging and bastard trenching).

The Girls of Forms IV. and V. cultivated plots 3 yds. by 2 in area, and in general the arrangement of her plot is left to the individual girl.

Most of the plants grown on the plots are raised from seeds or cuttings by the girls. The most suitable appear to be :—Sweet Peas, Stocks, Asters, Nasturtiums (Tom Thumb), Lobelia, Balsams, Tulips, Daffodils, Narcissi, Godetia.

They are also allowed to cultivate any suitable plants they care to bring from home.

Greenhouse Work :—Growing tomatoes, chrysanthemums, violas, carnations, Dorothy Perkins (Rose), fuchsias, pelargoniums. Tomatoes were grown experimentally thus :—

Pot used.	Height attained.	Flowers.	Trusses.	Remarks.
3-in.	Under 6 ins.	—	—	Pot-bound.
Seed Box 5-ins. deep.	9 ins. to 1 ft.	A few late	—	—
7-in.	2 ft. to 2½ ft.	2 or 3	2 or 3	Small trusses.
9-in.	3 ft. to 4 ft.	4 or 5	4 or 5	Large and well formed.

Herb Plot.—Ground divided into plots about 1 sq. yd. Parsley, sage, thyme, mint, endive, chives, chicory, marjoram, rosemary and lavender were grown.

French Gardening.

A small French Garden was made 2 yds. by 4 yds., with room enough for 12 cloches. Lettuce, radishes, onions, and cauliflowers were grown. (These used educationally.)

Hanging baskets filled with flowers raised by the girls proved very successful.

BEE-KEEPING AND POULTRY-KEEPING.

Third and Fourth Years.

Bee-keeping.

1. The advantages of Bee-keeping. The usefulness of Bees (*a*) as producers of food, otherwise wasted, (*b*) as promoters of fruitfulness by pollen-transference. Districts suitable for the industry.

2. Structure and life-history of the Bee. The egg, larva, pupa, imago; the queen, worker and drone. Varieties of the honey bee. Construction of the comb.

3. Bee-keeping appliances. Straw skeps. Modern appliances. Bar frame hive (different forms), including description of the various parts of a hive—outside case, brood chamber, section crates, &c.

4. Other modern appliances. Bar frames, with wax foundation. Sections, with wax guides. Feeders, smokers, Honey-extractors, wax-extractors.

5. Management of Bees. How to quieten bees. Transferring Bees from skeps to bar-frame hives. Stocking hives from "condemned bees," *i.e.*, those which would have been destroyed by their owners in taking the honey.

6. Management in Bar-frame hives, "spring-cleaning" of hives. Artificial swarming. Prevention of swarming. Taking honey. Queen-rearing. Uniting weak stocks. Feeding and wintering bees. Packing and removing bees.

7. Some difficulties, and how to overcome them. Robber-bees.—Enemies of Bees—wax moth, mice, &c. Diseases of Bees. How to deal with accidents arising from Bees.

8. Preparation of honey for the market. Cleaning sections, and glazing where required. Extracting honey and wax, and their sale.

The instruction in the above is accompanied by as much practical demonstration and work in the school apiary as possible. Sections 3, 4, and 8 afford indoor work for the pupils. The girls prepare the syrup and candy required for winter feeding.

Poultry-keeping.

The construction of houses, ventilation, lighting, internal fittings. Various systems of housing. Covered and other runs. Coops. Dust-baths. Feeding and drinking utensils. Buying and maintaining poultry plant.

General management. Eggs for hatching. The broody hen or clucker (indications of broodiness); her nest and special requirements; various methods of treatment during incubation, and when hatching off. Selection of site for the chicken coop. Rearing the chicks, home and foreign methods described and compared. Separation of chickens from the hen, and the sexes from one another. Distinctive treatment of growing stock, pullets for winter laying, cockerels for breeding purposes, "green" or "running" stock.

Selection of stock birds, the points indicating health, age, great laying qualities, and profitable table birds.

Mating up the breeding pen. Foods and feeding. Methods of feeding appropriate to stock at different ages, and wanted for various purposes. Foods commonly used, their properties and the circumstances leading to successful use of them. Foods to be avoided. Grit and other important details.

Anatomy. A short description of the alimentary canal, and egg-producing organs, emphasizing the peculiarities in the bird which are instructive as to its management. The chief breeds of Poultry—leading points by which they are readily distinguished. Conditions, such as climate, soil, &c., which should influence choice of breed. The useful characteristics of various breeds. The abuse of breeding for fancy points only.

The diseases of poultry. Insect pests—field vermin.
Management of Turkeys, Ducks, and Geese.
Marketing—preparing poultry for table. Storing and preserving eggs.
Artificial incubation and rearing. The pupils in turn take charge of the Hearson's Incubator, when in use; and take part in the care of the chicks in the foster-mother.

Analysis of the Time Table of the Knaresborough Rural Secondary School in Hours per School Week.

Note.—The figures in *italics* indicate the average age of the pupils.

Subject.	Form V.		Form IV.		Form III*a*.		Form III*b*.		Form III*c*.		Pre-paratory.	
	Girls (*14·7*).	Boys (*14·4*).	Girls (*14·5*).	Boys (*14·1*).	Girls (*13·2*).	Boys (*13·9*).	Girls (*12·3*).	Boys (*12·5*).	Girls (*none*).	Boys (*12·9*).	*10·8* Girls.	Boys.
Religious Instruction	2	2	2	2	2	2	2	2	—	2	2	2
Diary	1¾	1¾	1¾	1¾	1¾	1¾	1¾	1¾	—	1¾	1¾	1¾
English	1¾	2¼	1¾	2¼	3½	6¼	4¼	6	—	6¼	5¾	5¾
Mathematics*	2	5	2	4	3	3	3	3	—	3¾	3¼†	4†
History	1¼	¾	1¼	1¼	1¼	1¼	1¼	1¼	—	1½	1½	1½
Geography	1½	1½	1½	1½	1½	1½	2¼	2¼	—	2¼	1¼	1¼
Science:												
Experimental Science	1½	1½	1½	1½	1½	1½	1½	1½	—	1½	—	—
Hygiene	¾	¾	¾	¾	—	—	—	—	—	—	—	—
Nature Study‡	¾	3	¾	3	1½	2¼	1½	1½	—	1½	1½	1½
Singing	¾	¾	¾	¾	¾	¾	¾	¾	—	1½	1¼	1¼
Drawing	1½	1½	1½	1½	1½	1½	1½	1½	—	1½	1½	1½
Brushwork	—	—	—	—	—	—	—	—	—	—	¾	¾
Domestic Subjects:												
Needlework	2½	—	2½	—	2½	—	3	—	—	—	¾	—
Cookery	2¼	—	2¼	—	2¼	—		—	—	—	—	—
Laundry-work	2½	—	2½	—	—	—		—	—	—	—	—
Handicrafts:												
Elementary Handwork	—	—	—	—	—	—	—	—	—	—	1½	1½
Wood-work	—	2	—	1½	—	1½	—	1½	—	1½	—	1½
Gardening‡	—	1½	—	1½	—	1½	—	1½	—	—	—	—
Poultry Keeping	¾	¾	¾	¾	—	—	—	—	—	—	—	—
Physical Exercises	¾	¾	¾	¾	¾	¾	¾	¾	—	¾	¾	¾
Games and Recreation	3½	1½	3¼	1½	3¼	1½	3¼	1½	—	1½	2¾	2½
Sundries	¼	¾	¼	¼	½	½	¾	¾	—	½	—	—
Total No. of hours per week.	27¾	27½	27¾	27½	27½	27½	27½	27½	—	27½	26½	27¼

* Mathematics for boys include: Surveying, Account Keeping, and Commercial Practice.
† *i.e.*, Arithmetic.
‡ Nature Study for girls includes Gardening.

(ii) SEXEY'S RURAL SECONDARY SCHOOL, BLACKFORD, CHEDDAR.

NOTES UPON SCIENCE AND PRACTICAL WORK.

From Form IV. A. upwards Gardening for boys and Domestic Science for girls run parallel.

The work of the Science Course is brought to bear upon the Practical work of Gardening and Domestic Science.

Most correlation is carried out between Botany and Chemistry with Gardening. Chemistry and Physics are correlated with the Domestic Science.

The girls of VI. B. take a Course of Gardening based upon the cultivation of plants used for culinary purposes.

Nothing has been said about the correlation between Domestic Science and the Science teaching, or of the correlation of Wood-work in connection with Gardening and Agriculture. We regard these as of extreme importance.

The whole Science Course has been formed to lead naturally up to the Final Agricultural Course.

The Minimum Equipment for the Course of Science and Gardening, in addition to two Laboratories, is as follows :—

1. At least ¼ acre of land for ordinary Gardening operations, with tool-house sufficient for fourteen pupils.
2. ¼ acre of land for Fruit Culture.
3. A greenhouse of at least 23 ft. × 10 ft. with actual soil beds large enough for 12 to 14 pupils to work.
4. Two propagating frames at least 5 ft. × 7 ft.

The Minimum Requirements for the Agricultural Course are as follows :—

1. Workshops, Dairy, and Class Rooms.
2. Outbuildings (Pig Sties, Byre, Stable, Barn).
3. Twenty acres of land, consisting of Orchard, Pasture, Arable (2 acres).
4. Animals, Four Cows, Breeding Pigs, Two Sows, Fatling Pigs, Two Horses, Stocks of Bees, Three Breeds of Poultry.

SYLLABUS OF SCIENCE AND GARDENING.

Botany and Nature Study.

Forms I. and II.

Introduction to Nature Study.
Development of Frog, Cockroach, Water Beetle, Butterfly. Earthworm.
Birds. Swallow, Thrush, Skylark, Crows, Cuckoo, Duck.
Cultivation of love for Flowers and Animal Life.

Forms III. and IV. B.

Introductory Study of Flowers of School District.
Casual Study of Farm Crops and Grasses.
Animal Life. Observation of Birds, &c.
Soils. Varieties.
Water, its action on soil.
Chalk and limestone.
Clouds, Wind and Rain.

Form IV. A.

The Seed. Parts of a seed. Germination of seeds. Plant food in seeds. Good and bad seed. The presence of a good food supply in those seeds produced by healthy adult plants.

Condition for Germination.—Necessity of Light, Air, Warmth and Moisture. Experimental work in pots with seeds of different sizes, sown at

varying depths to show the effect of exclusion of air by deep sowing, or the absence of moisture produced by shallow sowing in dry seasons. Increase in weight and volume of seeds by the absorption of water.

The Parts of a plant and their uses, illustrating by a common wayside plant, *e.g.*, Groundsel.

General character of Roots adapted for the absorption of water from the soil. Examination of the roots of several plants in school gardens.

General character of Stems adapted for holding the branches erect and for carrying water from roots to leaves.

General character of Leaves adapted for receiving the maximum amount of light. Their rough structure and external features, taking a typical leaf, *e.g.*, Apple.

Transpiration, comparing the amount of water absorbed by the roots and given off by the leaves of such plants as Cucumber, Vine, Sunflower, requiring much water, and plants as Grasses, requiring small amount of water.

Experiments performed to show that the amount of water given off depends upon the extent of the leaf surface. In the taking of cuttings most of the leaves are taken off to prevent too rapid evaporation of water from the young cutting.

Respiration.—Draw a comparison between the respiration of a germinating seed, and the breathing of an animal with the burning in air of a candle or piece of charcoal showing that in all these cases oxygen is used and carbon dioxide given out. Hence a greenhouse or cold frame must be well ventilated to ensure a free supply of air.

Starch Formation.—Experimental work to show that the plant uses carbon dioxide from the air and the water obtained by its roots to form starch in its leaves, that this process only goes on in sunlight, and the starch is only formed in green leaves. Presence of starch in the seeds of most plants, a store of food for the young plantlet. Starch nearly insoluble in cold water, changed to sugar for its journey from leaf to seed, or fruit, where it is changed to starch again.

Form V. B.

The Flower.—Parts of a flower. Use of flowers to the plants. Organs for Reproduction. The differences between the flowers of wild and cultivated plants, examples of cultivated plants taken from school garden and wild plants from the ditches, hedgerows, and fields. Effect of cultivation upon the type of flower produced, taking cases where the plants have no longer to provide for certainty of reproduction, *e.g.*, the change from stamens to petals seen in roses, asters, &c.

Simple and Compound Flowers.—Our most prolific weeds arise from the seeds of compound flowers, in which each flower stalk bears from 50 to 200 or more seeds, *e.g.*, Thistle, Groundsel, Daisy, &c. The chances of reproduction by seeds are so much greater.

Fruit.—What it is. The part of the flower which lives and grows after fertilisation for the formation of seeds. Storage of food in the fruit for the young plantlets. The use made by man of these food stores, *e.g.*, Beans, Peas, Wheat, Barley, &c.

Common Types of Fruit studied from the point of view of their adaptation for the dispersal of the seed contained within them.

Obvious characteristics of seeds.—

Roots.—The root of carrot contrasted with that of Grasses. Structures of these roots according to the work they have to perform. Storage of Food in Roots and the use made by man of such stores, *e.g.*, Carrot, Turnip, Beet, Parsnip.

Kinds of Roots.—Annuals, Biennials, Perennials.

Stem.—Its chief functions, exposes the leaves, carries the food supply to and from the leaves; other functions—organs of vegetative propagation, *e.g.*, runners of Daisy, suckers of Roses; store places of nourishment, *e.g.*, Potato.

Structure of Typical Stem as in Cucumber or Marrow and modification of the same as (*a*) runner of Strawberry, (*b*) sucker of Mint, (*c*) tuber of Potato, (*d*) corm of Crocus.

Climbing Plants and their methods of support. Examples from school Gardens.

(*a*) Twining plants, *e.g.*, Scarlet Runner, Convolvulus.
(*b*) Root Climber, *e.g.*, Ivy.
(*c*) Hook Climbers, *e.g.*, Bramble, Rose, Goosegrass.
(*d*) Tendril Climbers, *e.g.*, Pea, Vetch, Clematis, Vegetable Marrow, Climbing Cucumber.

Methods of Branching.

Node and Internodes. Short Internodes of a Lettuce Plant, and the internodes on the Lettuce plant allowed to run to seed.

Leaves.—External features of a typical leaf.

Modifications, *e.g.*:—
(*a*) Cotyledons of Kidney Bean;
(*b*) Scales of Couch Grass;
(*c*) Pales and glumes of Grasses;
(*d*) Bulbs.

Buds.—As exemplified by Cabbage and Lettuce.

Plant foods and how the farmer applies them. Action of roots in taking up food in solution. Water culture experiments using food solutions containing Nitrogen, Phosphorus, Potash, and using such plants as (1) Maize representative of *Cereals*, (2) Turnips representative of *Roots*, (3) Broad Bean of *Leguminous Crops*.

Crops fed with Phosphorus by means of Superphosphates, with Lime and Phosphorus by Basic Slag, Potash by Kainit, Nitrogen by Nitrate of Soda.

Influence of Light upon plant growth. Comparison of densely planted corn crop with normally planted crop, experiment to be done in school gardens.

Inflorescences as illustrated by Perennial Rye Grass, Yarrow, Red Clover, Mustard.

Comparison between the flowers in the Wheat Plots and Clover Plots on the School Farm.

Culture Experiments in Pots.—Grow seeds in soil with caked surface and with stirred surface.

Form V. A.

Factors affecting the Germination of Seeds.

Cultural Work in Pots, experiments upon the germination of seeds under different conditions. Seeds to be grown in—
(*a*) Drained and Waterlogged Soils;
(*b*) Soil and Subsoil.

Experiments on Treatment of a Clay Soil. Seeds:—
(*a*) Planted when soil is wet;
(*b*) Planted when soil is dry;
(*c*) With surface allowed to cake;
(*d*) Surface of soil frequently stirred.

Identification of all farm and garden plants belonging to the Natural Orders:—Gramineae, Cruciferae, Leguminosae, Umbelliferae, Ranunculacae.

Grasses.—Study of the Grasses of the farm and the identification of all grasses of Agricultural importance.

Identification of Weeds.—Causes of their abundance and the methods for eradicating them.

More detailed study of flowers, the mechanism and arrangements to ensure pollination and fertilisation, so that they can carry out their work, viz., the production of seeds. Self pollination and cross pollination.

(*a*) Flowers adapted for Insects. Short Tongued and Long Tongued.

(*b*) Flowers adapted for Wind, *e.g.*, Plantain. More detailed study of Fruits and Seeds.

Study of Soils.—Differing classes of Soils.

(*a*) Sand; (*b*) Clay; (*c*) Loam; (*d*) Peat.

Properties of these soils respectively.

Functions of Springs.

Plant food.—Cultural work in Pots on following lines:—

(1) Seeds to be grown in poor sandy soil with varying amounts of Nitrogen, Phosphorus and Potash added.

(2) Mangolds to be grown in pots with varying amounts of salts.

(3) Seeds to be grown in pots containing—
- (*a*) Sand;
- (*b*) Clay;
- (*c*) Peat;
- (*d*) Loam; respectively.

(4) Seeds to be sown in Sand to which are added—
- (*a*) Ammonium Sulphate;
- (*b*) Ammonium Sulphate and Lime.

Principles of the Rotation of Crops.

Form VI. A.

Rapid Revision of the first three years' work.

Characteristic Natural Vegetation.

(*a*) Loam Soil—Coltsfoot, Bindweed, Groundsel, Chickweed.

(*b*) Clay Soil—Hornbeam, Oak.

(*c*) Peat Soil—Cotton Sedge, Quaking Grass.

Study of the following Natural Orders with special attention to representative species of agricultural importance:—

Ranunculaceae.	
Leguminosae - -	Bean, Vetches, Trifolium, Lucerne, &c.
Rosaceae - -	Meadow Sweet.
Compositae - -	Yarrow.
Labiatae - - -	Sage, Thyme.
Liliaceae - - -	Meadow Saffron.
Cruciferae - -	Kohl Rabi, Black Mustard, White Mustard, Charlock.
Caryophyllaceae.	
Umbelliferae - -	Carrot, Parsnip, Parsley.
Caprifoliaceae.	
Primulaceae.	
Solanaceae - -	Potato.
Boragineae.	
Scrophulariaceae -	Rattle Basket, Eyebright.
Salicineae.	
Iridaceae.	
Gramineae - -	Grasses.

Studies of the chief tissues in the—

(*a*) Root;

(*b*) Stem;

(*c*) Leaves

of a typical Dicotyledonous Plant, including herbs and trees.

The principal functions associated with the different organs and tissues of plants.

Chief features in the life history of a Pine and a Fern.

Gardening.

Form IV. A.

Proper and Improper Use of Garden Tools.

Methods of Cultivation, with reasons.

Preparation of land for seeds.—A fine seed bed, well drained: not too firm.

Sowing of seeds.—Disadvantage of sowing thickly, overcrowding of seedlings, insufficient supply of moisture and plant food for the young plants which have a weak start, and do not develop as well later.

Thinning.—Advantage of early thinning, to give more root space for the young plants.

Transplanting.—Seedlings reared under good conditions. Healthy young plants obtained. Need for watering young plants after transplanting, as the roots cannot get into close contact with the soil particles immediately.

Taking of Cuttings, e.g., Geranium, Marguerite, Carnation, Violas, &c.

Preparation of Cuttings for planting, taking off leaves to prevent rapid evaporation. Presence of a growing point near the top of cutting to attract moisture up the stem.

External Structure and Life History of Insects, taking Cabbage Butterfly, Cockchafer, Magpie Moth, Gooseberry Sawfly, as examples.

Form V. B.

Insects.—Study of Insect Pests, *e.g.*—

Collier Fly, pest on Broad Bean;
Click Beetle;
Turnip Fly;
American Blight on Apple Trees;
Magpie Moth;
Blackcurrant Mite;
Codlin Moth, Winter Moth;

Specimens found in school gardens to be collected and some preserved. Life Histories studied from the Board of Agriculture leaflets.

Preventive and Remedial Methods.

Insects helpful to the Gardener:—

Ladybird;
Ichneumon Fly feeds on Caterpillars.

Earthworms.

Their action upon the soil in making it lighter.

Pruning.—Effect of pruning, concentrates the energy of the plant upon a few buds, the flow of water from the roots being directed towards them. Tendency to produce strong fruit buds.

Budding.—A young bud from another tree is inserted into the stem of an old tree, receiving a good supply of food as it passes in a stream up the stem or trunk of the tree budded.

Grafting.—Here again a young shoot receives a liberal supply of food from the stock, by reason of flow of sap from its roots upwards.

Raising of plants for succession of crops.

Cultivation of the Soil :—

Deep Digging to increase the supply of available plant food.

Application of Artificial Manure.—(*a*) Basic Slag to supply Phosphorus to Grasses in soils inclined to become "sour," *e.g.*, the peaty moorland; (*b*) Superphosphates to Grass land on a limestone soil; (*c*) Nitrate of Soda to young plants; (*d*) Lime to "sour" soils.

Hoeing.—To prevent loss of moisture from the soil and to keep down weeds.

Sowing, Thinning, Transplanting, &c.

Keeping of Garden Accounts :—

Record of seeds sown and dates of operations carried out, &c.
Cost of seed.
Value of produce.

Form V. A.

Time for sowing and gathering various crops.

Storage of Crops.

Vegetative Reproduction of plants by—

(*a*) Cuttings, *e.g.*, Violas, &c.
(*b*) Layering, *e.g.*, Carnation, Apples, Pear.
(*c*) Budding, *e.g.*, Roses.
(*d*) Grafting, *e.g.*, Apple.

Systems of Grafting :—
(i) Whip and Tongue Grafting;
(ii) Whip Grafting;
(iii) Crown Grafting;
(iv) Somerset Saddle Grafting.

Class Room practice in budding and grafting upon artificial scions and stocks.

(e) *Principles of Fruit Tree and Bush Fruit Pruning.*—Summer and Winter Pruning.

Study of Insects which take part in the pollination of flowers. The methods by which pollination is effected.

Digging, Trenching, Ridging.
Advantages of these methods respectively on deep and shallow light and heavy soils.

The Rotation of Crops and arrangements of crops in the garden in order to secure it.
Application of Artificial Manures.

General Management of Green House and Frame.
Study of Insect and Fungoid Life in the garden and on the farm.

Collecting of Specimens. Fruits, Seeds, Flowers, Grasses, &c., and their preservation.

Excursions to be made for observational purposes on such subjects as soil formation, study of grasses, and weeds.

Form VI. A.

Seed Testing.—Samples of seeds to be tested in Germinating Case, and the percentage Purity and Germinating capacity of each sample calculated.
Care and Working of Plot showing *Systems of Rotation.*
Care and Working of Experimental Plot.

CORRELATION BETWEEN BOTANY AND GARDENING.

Botany.	*Gardening.*
Seeds and Seedlings.	Preparation of land for Seeds.
Conditions necessary for Germination.	Sowing of Seeds. Amount of Seed. Rate of Sowing. Depth of Sowing. Time of year for sowing.
	Seed-Testing, Germinating Power.
Plant food.	Thinning of seed beds.
(*a*) Reserves in seeds.	Transplanting of seedlings.
(*b*) Manufactured food—made by leaves—materials obtained by roots and leaves.	Precautions against over-crowding, proper distances between four various kinds of plants. Raising of plants under good conditions.
Food required by different crops.	Manuring.
	Rotation of crops.
Food supplies in soil.	Digging operations—to place food supplies at disposal of crops.
Food storage by Fruit Trees.	Pruning—concentration of energy upon certain parts.
Transpiration of Plants.	Taking of cuttings — precaution against too rapid evaporation from cuttings.
Reproduction of Plants—	Cuttings, Budding, Layering, Grafting.
(*a*) Seed;	
(*b*) Vegetative.	
Diseases of Plants.	Insect Pests and Fungoid.
Life History of Insect Pests.	Diseases of Garden Crops.
	Preventive and Remedial Measures.
Study of Fruits.	Specimens obtained from School Gardens.

Chemistry.

Form IV. A.

Study of the Air in relation to the processes of Combustion and the Breathing of Animals and Plants.

Oxygen and the process of Oxidation.

Carbon Dioxide.—Properties, its production by animal life and the use made of it by plant life. The same gas is formed during the combustion of substances containing Carbon.

Water Vapour and Carbon Dioxide in the Air.
Production of Rain, Fogs, Mists, &c.

Ventilation—means taken to get rid of superfluous Carbon-Dioxide produced from our bodies.

Hydrogen—Properties, the formation of water by its combination with Oxygen.

Water.—Study of Solutions and the Solubility of Substances.

Plant food in the Soil can only be used in a soluble form. Pure water unable to dissolve some plant foods, but water containing Carbon Dioxide in solution has this power.

Hard and Soft Water.—The action of hard water upon soap. The respective actions of Spring and Rain Water upon the soil when used for watering purposes in the garden.

Experiments to show the presence of Carbon Hydrogen.

Oxygen in common substances such as Sugar, Starch. Explain term Carbohydrate.

Ammonia.—Its production of Ammonium compounds by the action of Lime. Properties of the Gas. Reaction. Solubility, &c.

Experiments to show the presence of Carbon, Hydrogen, Oxygen, Nitrogen in White of Egg, Cheese, Milk-curd.

The presence of some or all of these elements in soils of various kinds, *e.g.*, Sand, Clay, Loam, Peat. All deficient in Nitrogen except Peat Soil.

Composition of plant substance. Presence of Water, Carbon, Nitrogen and Ash.

Form V. B.

Atomic weights and Chemical Equations.

Study of Elements forming alkaline compounds, e.g., Calcium, Sodium, Potassium, Limestone, Quicklime, Slaked Lime.

Production of heat by chemical action, when water is allowed to combine with any of the three substances mentioned.

Reaction of the substances formed, *e.g.*, Slaked lime, Caustic Soda, Caustic Potash.

Study of elements forming acid compounds.

E.g., Carbon, Phosphorus, Sulphur. Acids produced by burning these three respectively in Oxygen, *e.g.*, Carbonic Acid, Phosphoric Peroxide, Sulphur Dioxide.

Study of substances formed by the combination of the elements in the Acids and Alkalies considered.—Mostly processes of Neutralisation. *E.g., Calcium Carbonate* from Carbonic Acid Gas and Lime Water. Draw attention to the different forms of $CaCo_3$. Limestone, Marble, Chalk, Eggshells. *Sodium Carbonate* from Carbonic Acid and Caustic Soda.

Action of dilute acids upon Carbonates.

Composition of Baking Powder.—Prepare by mixing Sodium Bicarbonate and Cream of Tartar with Ground Rice.

Nitrate of Soda from Nitric Acid and Caustic Soda. Solubility of Nitrate of Soda. Very important plant food.

Sulphate of Ammonia from Sulphuric Acid and Ammonia.

Sodium Chloride from Hydrochloric Acid and Caustic Soda.

Study of Superphosphates and Basic Slag, their solubility and reaction to litmus. Their use as manures and neutralising bodies on "sweet" and "sour" soils respectively.

Bleaching Powder sometimes used as disinfectant for Stables.

Study of Acids present in substances of common use.

Production of alcohol from Sugar by Fermentation. Action of Yeast.

Production of Acetic Acid from the alcoholic liquor.

Production of Lactic Acid in Milk. Action of bacteria. Test degree of acidity of milk with standard soda solution. Method used in cheese making.

Study of Soap.—Formation from tallow and other fats and caustic soda.

Composition of Milk.—Presence of sugar, Fat, Albuminoids and water.

Composition of their foodstuffs:—

Sugar and Fat contain Carbon, Hydrogen, Oxygen.

Albuminoid or Casein contains these three and Nitrogen.

Presence of Starch (a carbohydrate) in Potatoes, Wheat, Barley, &c.

Combustion of Sugar, Starch, Fat in the body with the formation of Carbon Dioxide and Water.

Form V. A. (Boys).

Composition of Plants.—Scheme of Analysis for the following: Water, Carbon, Hydrogen, Nitrogen, Ash.

Analysis of Ash.—Presence of Iron, Phosphoric Acid, Calcium, Magnesium Sodium Potassium, Chloride, Sulphate.

Composition of Soil.—A fertile soil must fulfil following conditions :—

(i) Contain reasonable percentage of Nitrogen, Phosphoric Acid and Potash.

(ii) Contain sufficient $CaCo_3$ to ensure permanent neutral reaction.

(iii) Must be capable of fermenting organic matter and nitrifying the ammonia produced.

(iv) Must contain a reasonable proportion of sand to ensure a certain degree of porosity and freedom in working.

Examination of Soil for the following :—Calcium, Carbonate, Nitrogen, Phosphoric Acid, Potash, Nitrates, Sand.

Various kinds of soil to be analysed.

Composition of Spring Water.—Complete Analysis.

Study of Artificial Manures.

Phosphate Manures, e.g., Superphosphates, Basic Slag, Raw Bone, Raw Guano, Mineral Phosphates, Bone, Phosphates. Solubility and changes on charring. Production of Superphosphates from Mineral Phosphates by strong Sulphuric Acid. Change in solubility. Action of Lime on Superphosphates, change from soluble to insoluble. Action of Ammonium Citrate on Reverted Phosphates. Compare to action in soil.

Potash Manures.—Muriate of Potash, Sulphate of Potash, Kainit. Examine each for purity and solubility.

Lime Manures.—Quicklime, Chalk, Gas Lime.

Nitrogenous Manures.—Nitrate of Soda, Sulphate of Ammonia, Guano, Simple tests on these manures.

The Mixing of Manures.—Chemical actions which take place on mixing various manures. Care to be taken when mixing as plant food may be lost to the soil owing to gases being given off, or substances rendered insoluble.

Laws of Chemical Combination.

Forms VI. A. and VI. B. (Boys).

Composition of Substances taken as Food by Animals.—Carbohydrates, Fats, Albuminoids. More detailed.

Complete Analysis of Milk for Butterfat, Solids, Sugar, Albuminoids. Use of Gerber.

Composition of Wheat Flour.—Gluten, an Albuminoid, Starch, a carbohydrate.

Composition of Food Stuffs, e.g., Oat-meal, Bean-meal, Hay. Note that Bean-meal contains most NH_3 and Hay least.

Show relative amounts of fibre by boiling with dilute Sulphuric Acid. Test filtrate for Sugar and Albuminoids.

Composition of Cereals, Beans and Peas, Hay and Straw, Roots.

Experiments on Oil Cake.

Extraction of Oil by Soxhlet's Method.

Presence of Albuminoids and Carbohydrates.

Woody fibre and Sand. Condiments.

Mucilage in Linseed Cake.

Composition of Butter.—Curd, Salt, Percentage of Water.

Composition of Cheese.—Fat, Albuminoids.

Find percentage of Fat by Soxhlet's method.

Use of Acidimeter.—Preparation of $\frac{N}{9}$ Sodium Hydrate solution Preparation of Sulphuric Acid of Density 1·82 for use with Gerber Machine.

Test for Boiled and Unboiled Milk.—Test for Enzymes.

Tests for Boric Acid and Formalin in Milk.

Estimation of the Values of Artificial Manures.—Unit method.

Estimation of Values for Feeding Stuffs.
Digestibility of Foods.

Action of Ferments in Digestion.

Physics.

Form IV. A.

Measurements of :—

Length.—Taking the yard as unit, pass to the Chain. Measuring up of fields, garden plots, school buildings, &c. The use of Scales. Drawing plans to scale.

Areas.—Square chain, acre. Show how irregular fields can be calculated by dividing up into triangles. Formation of right angle by means of the Chain.

Volumes.—Cubic yard, foot inch. Introduce centimetre and metre, and so pass to cubic centimetre. Calculation of volumes.
Graduated cylinder. Burette. Pipette.
Rough calculation of heaps of stones, stacks, &c.

Weight.—English weights. The Balance. Metric weights. Postage Calculation. Weigh blocks of wood having same volume and observe they have different weights.

Density.—Calculate the weight per c.c. of wood, iron, lead. Show how areas and volumes can be compared by weighing.

Relative Densities.—Weigh equal volumes of various liquids, *e.g.*, water, brine, sugar solution.

Temperature.—Reading of temperatures, on Centigrade and Fahrenheit Scales, using Dairy Thermometers.

Atmospheric Pressure.—Reading of Barometer.

Form V. B.

Relative Density.—Determination of Specific Gravity of solidity milk, sulphuric acid, paraffin oil.
Use of Hydrometer, Twaddell's Hydrometer. Lactometer for finding specific gravity of milk. Specific Gravity of milk fat, ·9; Specific Gravity of milk, 1·032; hence cream rises to surface.

Nicholson's Hydrometer.—Show that solids lose weight apparently equal to weight of volume of liquid displaced.

Principle of Archimedes.

U-tube of Syphon.—Liquids always strive to reach the lowest level. Explain syphon independent upon atmospheric pressure.

Common Pump.— Its action, also dependent upon atmospheric pressure.

Barometer.—Principle of the Instrument.
Syphon and Cistern Barometer. Variation of pressure with altitude and weather conditions.
Daily reading and recording of Barometric Pressure.

Pressure of Gases.—Boyle's Law.

Boys only.

Machines.
Lever. The three orders of levers with practical farm and outdoor illustrations, *e.g.*, Steelyard, Crowbar, Scales, Wheelbarrow.

Pulleys.—Arrangement of Pulleys.
Cheese press as examples of lever and pulley.

Wheel and Axle as applied in Bicycle, Windlass, Chaff Cutter, Ratchet Wheel, Cream Separator, Butter Worker.

Inclined Plane.

Forces acting in Simple Structures, e.g., Field Gate, Timber in Roof.

Centre of Gravity.—Adjustment of loads on two-wheel vehicles. Method of swinging field gates.

Principle of Levelling, e.g., in Drainage, securing "Fall."

Girls only.

Distinction between Heat and Temperature.

Expansion of Solids, Liquids, Gases, by Heat.

Expansion of Water produced by Freezing and the effect of this phenomenon upon the soil.

Conduction of Heat by Solids and Liquids.

Rate of Cooling in Earthenware and Metal Vessels. Insulators in Tea Pot and Hot-water jug handles. Use of wool for clothing to retain body heat.

Convection Currents in Liquids and Gases.

Absorption and Radiation of Heat.—Temperature of light and dark soils.

Evaporation. Latent Heat.

Meteorology.—Wet and Dry Thermometers, Maximum and Minimum, Soil Thermometer, Rain Gauge.

Form V. A. Boys.

Work of V. B. Girls only and also :—

Specific Heat of Sand and Clay.
Conductivity of Sand and Clay.
Temperature of Wet and Dry Soils.
Effect of Aspect of Land upon Temperatures of Soil.
Effect of Evaporation on Soil Temperature.
Capacity of Soils for water. Experiments to determine.
Experiments to find percentage of Air in Soil.
Capillary action in Soils.
Water-holding power.

CORRELATION BETWEEN CHEMISTRY, PHYSICS, AND GARDENING.

Chemistry and Physics.	*Gardening.*
Composition of Soil.	Treatment of Clay, Loam, and Sand Soil.
Various kinds of Soil.	
Physical Properties of Soils.	Working of Deep and Shallow, Dry and Wet Soils.
Composition of Plants.	
Variation in various Fruits, Roots, &c.	Ripening of Fruit.
Presence of Sugars.	Time of harvesting Crops.
Capillarity in Soils.	Preparation of Seed beds.
Temperature of Soils.	Treatment of Waterlogged Soils.
Evaporation of water from Soils.	Drainage.
	Hoeing to prevent loss of water in dry weather through evaporation.
	Light and dark coloured soils.
	Suitable positions for crops.
	Arrangement of crops to prevent shading, &c.

Chemistry and Physics.	*Gardening.*
Measures— Area. Weights.	Laying out of Garden Beds.
Calculating upon amount of Seed.	Rate of sowing Seed.
Weight of Crops.	Weighing up of Crops.
Weather Observations.	Taking of Readings at the Meteorological Station in school gardens.
Atmospheric Pressure.	
Temperature. Air, Soil.	
Greenhouse, &c.	
Rainfall.	
Action of Frost.	Weathering of Soil.

SYLLABUS OF FINAL AGRICULTURAL COURSE.

Form VI. B. Boys only.

Agricultural Botany.

Farm Seeds.
Purity.
Germination Capacity.
Speed of Germination or germination energy.
Weight, and weight of seed to be used per acre.
Form, colour, brightness, and smell.
Common grasses of the Farm.
Grasses and Clovers for Temporary and Permanent Pastures.
Weeds of the Farm. Their injurious effect.
Weeds of Pasture land.

Foods and Feeding Stuffs.

Knowledge of Carbohydrates, fats, and albuminoids, and the functions each perform in the animal body.
Digestive coefficients and digestibility of foods.
Maintenance of Animal Heat, and waste of tissues.
Valuation of food stuffs by unit method.
Suitable foods for animals of all ages.
Formation of fat, flesh, and bone.
Economical use of foods and manurial value of foods.
Albuminoid Ratio of individual foods and of mixtures.
Preparation of Rations on a scientific basis for all Farm Stock.

Manures and Manuring.

Definition and Classification of Manures.
Valuation of Manures by unit method.
Composition of the common manures.
Farm Yard Manure, its proper preservation and effect on different classes of soil.
The needs of various Farm Crops, and quantities required to supply same
Improvement and application.
Economical use of manures to all Farm Crops.
Manuring of Grass Land, Arable Land, and Moor Land.
Time of application and knowledge of current Market prices.
Practical tests for phosphates, potash, nitrogen, and purity of manures.
Simple tests to ascertain if soils are deficient in lime.
Various methods of distribution, and mixing of manures.

Bee-keeping.

The treatment of Bees and Hives for the Winter.
Natural History of the Bee.
Bee Appliances and how to use them.
Subduing, handling, and driving of Bees.
Method of cleaning a Hive.
Swarming, natural and artificial.
Removing of honey from circular Hive and Bar Frame.

Queen rearing.
The general management of the Bees for a year.
Packing and Marketing honey.
Making of Sections, and Storage.

Agriculture.
Description of the grass and clover seeds of the Farm.
Grasses to suit the various soils.
Temporary and Permanent mixtures to suit the various soils.
The chief points of Hay, and how to judge it.
Pastures and impurities found in them.
Methods of laying down pasture and manuring.
Description of the grasses and clovers and how to distinguish them.
Seed testing. Germinating capacity, purity, and impurities.

Soils.
Origin, formation, physical properties, and chemical constituents. Effect of light and other agencies on soils.
Conditions under which soils become fertile.
Principles of land cultivation and drainage.

Live Stock.
Description of the local breeds. Breeding and rearing of Stock. Points in judging Stock.
Marketing Live Stock.

Crops and Cropping.
Rotation of crops, Roots, Cereals, and Forage Crops.
General management from time of Sowing to Harvesting.

Particulars as to Catch Crops.
Stocking of Farms, Dairy and Arable.
Labour. Cost of various farm operations, ploughing, sowing, harvesting, threshing, &c.
Diseases of Farm Stock, and treatment.

Practical Agriculture.
Feeding of Pigs and care of same.
Feeding of Poultry and care of same.
Feeding of Cattle and Horses.
Rearing of Calves.
Lifting of Mangels and storage of same.
Method of knowing yield per acre.
Sowing of Catch Crops and treatment of land.
Preparation of food for Stock.
Making Butter and Cheese.
Separation of Milk and treatment of Cream.

Boys and Girls.

Farm Book-keeping.
Advantages of Agricultural Book-keeping and notes of observations.
Explanation of terms: Debtor, Creditor, Discount, Interest, Capital. How to keep Waste Book, Journal, Ledger, Cash Book.
Methods of keeping Accounts.
The whole year's accounts of the School Farm.
Valuations and preparation of Balance Sheet. Capital.

Poultry.
Selection and improvement of Stock.
Description of the various breeds.
Classification of poultry in regard to laying, general purpose and table fowls.
Breeds for the various soils and climates.
Hatching and rearing, artificial and natural.
Formation of egg and chicken.

Feeding for egg-production, and fattening.
Houses and housing, areas suitable for each breed.
Preparation of poultry and grading of eggs for Market.
Preservation of eggs, and packing.
Diseases, cause and treatment.

Dairying.

Description of the Churn, Butter-worker, and other utensils, such as Separator and Cooler.

Principles of Separation. Cream ripening.

Milk, treatment of same, its source, chemical and physical properties, milk testing and sterilization, and pasteurization of milk and cream.

Use of Lactometer and marketing of milk.
Preparation of cream for churning.
Cream raising and influence of temperatures.
Bacteriology, Dairy Bacteriology and use of Microscope.
Dairy Buildings and Cow Sheds.
Site, construction, drainage, ventilation and general arrangement.
Keeping of Milk Records.
Dairy Cattle, different Breeds.
Breeding, feeding and management. Points of a Dairy Cow.

Girls only.

Domestic Science.

Cookery, Needlework, Housewifery.
Gardening.

SEXEY'S SCHOOL, BLACKFORD, SOMERSET.

Analysis of the Time Table in Hours per School Week.

(*Note.*—The figures in *italics* indicate the average age of the pupils.)

Subject.	Forms I. and II.		Form III.		Form Lower IV.		Form Upper IV.		Form V.		Form VI.	
	Boys (*9·7*).	Girls (*9·7*).	Boys (*11·9*).	Girls (*11·9*).	Boys (*12·7*).	Girls (*12·7*).	Boys (*13·9*).	Girls (*13·9*).	Boys (*14·11*).	Girls (*14·11*).	Boys (*16·6*).	Girls (*16·6*).
Religious Instruction.	1½		1½		1½		1½		1½		1½	
English	8·35		3·5		3½		2½	—	3·40		3·35	3·20
Geography	2·50		2·55		1·25		1·55		2½		2½	
History	2		2½		2·5		1·55		2½		2½	
French	1½		3·25		3·10		3·40		3·25		3·25	
Mathematics	3·40		6½		5·35		5½	—	5·20		6½	6·5
Science	2½		2·40		3·10		4½	—	4½	2½	3·20	2*
Drawing	2·20	1·20	1½		2·10		1½	—	1½	1·5	2	1½
Music and Singing	1·5	1½	1½		½		½	—	½	1½	—	—
Manual Instruction.	—	—	1	—	1½	—	2	—	1½	—	1	—
Domestic Subjects	—	1	—	1	—	2½	—	2	—	2½	—	—
Physical Exercises.	½		½		½		½	—	—	—	—	—
Correspondence	—	—	—	—	½	—	½	—	—	—	—	—
Mensuration	—	—	—	—	—	—	—	·40	½		—	½
Total Number of hours per week.	26·40	26·40	26·40	26·40	26·40	26·40	26·40	26·40	26·40	26·40	26·40†	26·40

* Girls extra time for English subjects and private study.
† An extra hour per week is given to advanced pupils of Form VI. in Trigonometry.